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METHOD AND DEVICE FOR REPLACEMENT OF NUCLEAR REACTOR PRESSURE
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METHOD AND DEVICE FOR REPLACEMENT OF NUCLEAR REACTOR PRESSURE
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Claims

•/2

1. A method for replacement of a nuclear reactor pressure vessel characterized by the following facts: after the fuel and inner structural parts are removed from the nuclear reactor pressure vessel and transferred to a maintenance building for storage, equipment for removing the nuclear reactor pressure vessel is set above the nuclear reactor building; an opening is formed on the roof of the nuclear reactor building; from the opening, said nuclear reactor pressure vessel is removed; on the other hand, a new nuclear reactor pressure vessel is installed through the opening of said roof; then, the fuel and inner structural parts are transferred from said maintenance building back into the nuclear reactor pressure vessel for reloading.

2. A method for replacement of a nuclear reactor pressure vessel characterized by the following facts: after the fuel and inner structural parts are removed from the nuclear reactor pressure vessel and transferred to a maintenance building for storage, equipment for removing the nuclear reactor pressure vessel is set above the nuclear reactor building; an opening is formed on the roof of the nuclear reactor building; the pressure vessel and heat shielding body of nuclear reactor are sequentially removed; from the opening on the other hand, a new heat shielding body and a new nuclear reactor pressure vessel are installed through the opening of said roof; then, the fuel and inner structural parts are transferred from said maintenance building back into the nuclear reactor pressure vessel for reloading.

3. The method for replacement of nuclear reactor pressure vessel described in Claim 2, characterized by the fact that the inner diameter of the new heat shielding body is selected to be

[Numbers in the margin indicate pagination in the foreign text.]

larger than the outer diameter of the nozzle portion of the new nuclear reactor pressure vessel.

4. The method for replacement of nuclear reactor pressure vessel described in Claim 1, characterized by the following facts: after the nuclear reactor pressure vessel is removed, the control rod driving device's handler is removed from the opening on the roof; then the pedestal is remodeled and a new internal pump/control rod driving device's handler is installed through the opening on said roof.

5. The method for replacement of nuclear reactor pressure vessel described in Claim 1, characterized by the fact that the nuclear reactor pressure vessel is of a type corresponding to a circulating system utilizing an internal pump.

6. The method for replacement of nuclear reactor pressure vessel described in Claim 1, characterized by the following facts: after the nuclear reactor pressure vessel is removed, the internal pump/control rod driving device's handler is removed from the opening on the roof; then, a new internal pump/control rod driving device's handler is installed through the opening on said roof.

7. A method for replacement of nuclear reactor pressure vessel characterized by the following facts: after the fuel and inner structural parts are removed from the nuclear reactor pressure vessel and transferred to a maintenance building for storage, equipment for removing the nuclear reactor pressure vessel is set above the nuclear reactor building; from an opening formed on the roof of the nuclear reactor beforehand, said nuclear reactor pressure vessel is removed; on the other hand, a new nuclear reactor pressure vessel is installed through the opening of said roof; then, the fuel and inner structural parts are transferred from said maintenance building back into the nuclear reactor pressure vessel for reloading.

8. A device for replacement of nuclear reactor pressure vessel characterized by the

following facts: the device has the following parts: a frame set straddling the nuclear reactor building, accommodating equipment carried on the frame and connected by a third air lock to a removal chamber with a first air lock mounted on the upper side and a hoisting chamber with a second air lock mounted on the lower side, a crane which is set on the ceiling surface of said hoisting chamber and which hoists the nuclear reactor pressure vessel from said nuclear reactor building to the hoisting chamber, a flatcar which moves on the floor of said removal chamber and hoisting chamber, a tower crane which is carried on said frame and which lowers the nuclear reactor pressure vessel transferred to said removal chamber to outside said accommodating equipment, and a running flatcar which runs to transfer the nuclear reactor pressure vessel lowered by said tower crane to the maintenance building; while the nuclear reactor pressure vessel is removed from said nuclear reactor building to the maintenance building for disassembly, cleaning of pollution, repair, and storage, a new replacement nuclear reactor pressure vessel is lowered in and installed in said nuclear reactor building.

9. The device for replacement of nuclear reactor pressure vessel described in Claim 8, characterized by the fact that the accommodating equipment is made of a hoisting-up chamber alone.

10. The device for replacement of nuclear reactor pressure vessel described in Claim 8, characterized by the fact that the accommodating equipment is made of a hoisting-up chamber alone, and the tower crane is changed to a frame set on the ground surface.

11. The device for replacement of nuclear reactor pressure vessel described in Claim 10, characterized by the fact that a crawler crane is used instead of a tower crane.

12. The device for replacement of nuclear reactor pressure vessel described in Claim 8, characterized by the fact that the accommodating equipment is made of a hoisting-up chamber

alone, and the flatcar has a structure that allows it to move from one end of the frame to the other end.

13. The device for replacement of nuclear reactor pressure vessel described in Claim 8 or 12, characterized by the fact that the flatcar moving on the frame is equipped with a pneumatic float-up-type moving device.

14. The device for replacement of nuclear reactor pressure vessel described in Claim 12, characterized by the following facts: the hoisting-down[sic; hoisting-up] chamber has an air dome structure; a gantry structural body is set inside it; and the crane for hoisting the nuclear reactor pressure vessel is mounted on the gantry structural body.

15. The device for replacement of nuclear reactor pressure vessel described in Claim 8 or 14, characterized by the fact that the frame is of a running type, and the nuclear reactor pressure vessel is carried directly on the running flatcar by a crane mounted on the gantry structural body.

16. A device for replacement of nuclear reactor pressure vessel characterized by the following facts: the device has the following parts: a crawler crane which hoists the nuclear reactor pressure vessel from a nuclear reactor building set on the ground surface, a simple accommodating equipment which is set in said nuclear reactor building and has the nuclear reactor pressure vessel hoisted into it, and a running flatcar which directly carries the simple accommodating equipment with the nuclear reactor pressure vessel joined to it by said crawler crane from the nuclear reactor building and transfers it to the maintenance building; while the nuclear reactor pressure vessel is removed from said nuclear reactor building to the maintenance building for disassembly, cleaning of pollution, repair, and storage, a new nuclear reactor pressure vessel for replacement is lowered in and installed in said nuclear reactor building.

Detailed explanation of the invention

[0001]

Industrial application field

/3

This invention pertains to a nuclear plant that has entered the stage of power generation. In particular, this invention pertains to a method and a device for replacement of nuclear reactor pressure vessel, characterized by the fact that in order to ensure the long-term safety of the nuclear plant, the nuclear reactor pressure vessel is removed from the nuclear reactor building and, in a maintenance building set within the perimeter of the power plant, the nuclear reactor pressure vessel is cleaned to get rid of pollution, disassembled, and stored; and, on the other hand, a new nuclear reactor pressure vessel for replacement is lowered in and installed in said nuclear reactor building.

[0002]

Prior art

Nuclear power plants are usually designed to have a lifetime of 30 or 40 years. However, not all of the equipment in the plant has the same lifetime. If the nuclear reactor pressure vessel, which is the main equipment of the plant, is replaced in a timely manner by a new nuclear reactor pressure vessel, it is possible to prolong the lifetime of the nuclear power plant and to reduce the total amount of the waste generated. This method has become attractive.

[0003]

Problems to be solved by the invention

When the nuclear reactor pressure vessel that has started power generation is removed from the nuclear reactor building or when a new nuclear reactor pressure vessel is installed into the nuclear reactor building, it is necessary to ensure that no radioactive substance leaks from the nuclear reactor building to outside the building.

[0004]

When the nuclear reactor pressure vessel is removed from the nuclear reactor building, one may adopt a method by which the nuclear reactor pressure vessel is cut into small sections inside the nuclear reactor building and the sections are removed from the large-part access port, and then the members of the new nuclear reactor pressure vessel are installed through the large-part access port and are assembled inside the nuclear reactor building. In this case, no radioactive substance is released outside the building as the nuclear reactor pressure vessel is replaced. On the other hand, however, the nuclear power plant has to be shut off for a long time. This is a disadvantage.

[0005]

Consequently, there is a demand to perform replacement of the nuclear reactor pressure vessel without shutting off the nuclear power plant for a long time. For this purpose, it is necessary to install an inlet equipped with air locks that allows removal/replacement of the nuclear reactor pressure vessel as a single body after the building stage of the nuclear power plant, and it is necessary to install it as a new part while the plant is in operation.

[0006]

In consideration of the difficulty in transferring the nuclear reactor pressure vessel as a heavy member, it is preferred that the access port be set on the roof of the nuclear reactor building right above the nuclear reactor pressure vessel. In the design of the roof of a conventional nuclear reactor building, only the strength for withstanding snow deposition is taken into consideration. Consequently, in order to install an inlet structure equipped with air locks on the roof, it is necessary to change the concept of construction of the building or to adopt other means.

[0007]

When the disposed nuclear reactor pressure vessel is processed using a conventional waste processing method, it is divided into small sections which are enclosed in containers for storage. In this case, however, the dividing operation needs significant labor, and it is necessary to process any radioactive powder generated in the dividing operation. Also, as the nuclear reactor pressure vessel is a strong structural member, if it is used as a vessel for storing the radioactive substance, it is possible to omit the dividing operation and the operation for processing the fine radioactive powder generated in the dividing operation. Consequently, it is necessary to consider a method of using the used nuclear reactor pressure vessel as a waste-storing vessel.

[0008]

When the used nuclear reactor pressure vessel is used as a waste-storing vessel by removing pollution and maintaining the surface of the nuclear reactor pressure vessel, it is

possible to prevent diffusion of the radioactive substance from the nuclear reactor pressure vessel during storage, and it is necessary to perform volume reduction operations as well as pollution elimination and disassembly operations for the internal structural parts stored in the nuclear reactor pressure vessel. In order to reduce exposure to radiation, these operations are carried out as remote operations by means of various automatic equipment and robots. However, in order to use this remote operation equipment effectively, it is believed necessary to perform the operation in a factory automation (FA) plant or other maintenance building.

[0009]

When an operation is performed to take the nuclear reactor pressure vessel integrally from/into the roof portion of the nuclear reactor building, from a safety viewpoint it is preferred that the used fuel not be stored in the fuel storing pool. Consequently, it is necessary to consider a method for taking the used fuel from the fuel-storing pool to a fuel-storing facility outside the nuclear reactor building for storage.

[0010]

The purpose of this invention is to solve the aforementioned problems by providing a method and device for replacement of nuclear reactor pressure vessel, characterized by the fact that when the nuclear reactor pressure vessel is removed from/replaced in the nuclear reactor building as a single body, there is no need to give special consideration to reinforcement of the roof of the nuclear reactor building, emission of the radioactive substance from the nuclear reactor building can be prevented, and exposure of workers to radiation during the operation can be reduced.

[0011]

Means to solve the problems

In order to solve the aforementioned problems, Claim 1 of this invention provides a method for replacement of nuclear reactor pressure vessel characterized by the following facts: after the fuel and inner structural parts are removed from the nuclear reactor pressure vessel and transferred to a maintenance building for storage, equipment for removing the nuclear reactor pressure vessel is set above the nuclear reactor building; an opening is formed on the roof of the nuclear reactor building; from the opening, said nuclear reactor pressure vessel is removed; on the other hand, a new nuclear reactor pressure vessel is installed through the opening of said roof; then, the fuel and inner structural parts are transferred from said maintenance building back into the nuclear reactor pressure vessel for reloading.

[0012]

Claim 2 provides a method for replacement of nuclear reactor pressure vessel, characterized by the following facts: after the fuel and inner structural parts are removed from the nuclear reactor pressure vessel and transferred to a maintenance building for storage, equipment for removing the nuclear reactor pressure vessel is set above the nuclear reactor building; an opening is formed on the roof of the nuclear reactor building; from the opening, the pressure vessel and heat shielding body of the nuclear reactor are sequentially removed; on the other hand, a new heat shielding body and a new nuclear reactor pressure vessel are installed through the opening of said roof; then, the fuel and inner structural parts are transferred from said maintenance building back into the nuclear reactor pressure vessel for reloading.

[0013]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 3, for the method described in Claim 2, the inner diameter of the new heat shielding body is selected to be larger than the outer diameter of the nozzle portion of the new nuclear reactor pressure vessel. According to the method for replacement of nuclear reactor pressure vessel described in Claim 4, for the method described in Claim 1, after the nuclear reactor pressure vessel is removed, the control rod driving device's handler is removed from the opening on the roof; then, the pedestal is remodeled, and a new internal pump/control rod driving device's handler is installed through the opening on said roof.

/4

[0014]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 5, for the method described in Claim 1, the nuclear reactor pressure vessel is of a type corresponding to a circulating system utilizing an internal pump.

[0015]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 6, for the method described in Claim 1, after the nuclear reactor pressure vessel is removed, the internal pump/control rod driving device's handler is removed from the opening on the roof; then, a new internal pump/control rod driving device's handler is installed through the opening on said roof.

[0016]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 7, after the fuel and inner structural parts are removed from the nuclear reactor pressure vessel and transferred to a maintenance building for storage, equipment for removing the nuclear reactor pressure vessel is set above the nuclear reactor building; from an opening formed beforehand on the roof of the nuclear reactor, said nuclear reactor pressure vessel is removed; on the other hand, a new nuclear reactor pressure vessel is installed through the opening of said roof; then, the fuel and inner structural parts are transferred from said maintenance building back into the nuclear reactor pressure vessel for reloading.

[0017]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 8, the device has the following parts: a frame set straddling the nuclear reactor building, an accommodating equipment which is carried on the frame and which is connected by a third air lock to a removal chamber with a first air lock mounted on the upper side and a hoisting-up chamber with a second air lock mounted on the lower side, a crane which is set on the ceiling surface of said hoisting-up chamber and which hoists the nuclear reactor pressure vessel from said nuclear reactor building to the hoisting-up chamber, a flatcar which moves on the floor of said removal chamber and hoisting-up chamber, a tower crane which is carried on said frame and which lowers the nuclear reactor pressure vessel transferred to said removal chamber to outside said accommodating equipment, and a running flatcar which runs to transfer the nuclear reactor pressure vessel lowered by said tower crane to the maintenance building; while the nuclear reactor pressure vessel is removed from said nuclear reactor building to the maintenance building

for disassembly, cleaning of pollution, repair, and storage, a new nuclear reactor pressure vessel for replacement is lowered in and installed in said nuclear reactor building.

[0018]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 9, for the device described in Claim 8, the accommodating equipment is made up of a hoisting-up chamber alone.

[0019]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 10, for the device described in Claim 8, the accommodating equipment is made up of a hoisting-up chamber alone, and the tower crane is changed to a frame set on the ground surface.

[0020]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 11, for the device described in Claim 10, a crawler crane is used instead of a tower crane.

[0021]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 12, for the device described in Claim 8, the accommodating equipment is made up of a hoisting-up chamber alone, and the flatcar has a structure that allows it to move from one end of the frame to the other end.

[0022]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 13, for the device described in Claim 8 or 12, the flatcar moving on the frame is equipped with a pneumatic float-up-type moving device.

[0023]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 14, for the device described in Claim 12, the hoisting-up chamber has an air dome structure; a gantry structural body is set inside it; and the crane for hoisting the nuclear reactor pressure vessel is mounted on the gantry structural body.

[0024]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 15, for the device described in Claim 8 or 14, the frame is of a running type and the nuclear reactor pressure vessel is carried directly on the running flatcar by a crane mounted on the gantry structural body.

[0025]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 16, the device has the following parts: a crawler crane which hoists the nuclear reactor pressure vessel from a nuclear reactor building set on the ground surface, simple accommodating equipment which is set in said nuclear reactor building and has the nuclear reactor pressure vessel hoisted into it, and a running flatcar which directly carries the simple accommodating

equipment with the nuclear reactor pressure vessel joined to it by said crawler crane from the nuclear reactor building and transfers it to the maintenance building; while the nuclear reactor pressure vessel is removed from said nuclear reactor building to the maintenance building for disassembly, cleaning of pollution, repair, and storage, a new nuclear reactor pressure vessel for replacement is lowered in and installed in said nuclear reactor building.

[0026]

Function

According to the method for replacement of nuclear reactor pressure vessel described in Claim 1 of this invention, after the fuel and inner structural parts are removed from the nuclear reactor pressure vessel and transferred to a maintenance building for storage, equipment for removing the nuclear reactor pressure vessel is set above the nuclear reactor building; an opening is formed on the roof of the nuclear reactor building; from the opening, said nuclear reactor pressure vessel is removed; on the other hand, a new nuclear reactor pressure vessel is installed through the opening of said roof; then, the fuel and inner structural parts are transferred from said maintenance building back into the nuclear reactor pressure vessel for reloading. Consequently, the nuclear reactor pressure vessel can be replaced in a short time free of diffusion of the radioactive substance to the surrounding [area], and after replacement the large structural members can be safely stored for a long time.

[0027]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 2, from the opening, the pressure vessel and heat shielding body of the nuclear reactor are

removed sequentially; on the other hand, a new heat shielding body and a new nuclear reactor pressure vessel are installed through the opening of said roof. Consequently, it is possible to replace the nuclear reactor pressure vessel and heat shielding body in a short time free of diffusion of the radioactive substance to the surrounding [area].

[0028]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 3, for the method described in Claim 2, the inner diameter of the new heat shielding body is selected to be larger than the outer diameter of the nozzle portion of the new nuclear reactor pressure vessel. Consequently, it is possible to further shorten the time of operation for taking the new heat shielding body as a single body into the nuclear reactor building for replacement.

[0029]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 4, for the method described in Claim 1, after the nuclear reactor pressure vessel is removed, the control rod driving device's handler is removed from the opening on the roof; then, the pedestal is remodeled and a new internal pump/control rod driving device's handler is /5 installed through the opening on said roof. Consequently, it is possible to change to a circulating system utilizing an internal pump with even higher safety, and it is possible to shorten the fuel exchange period. Also, it allows change to a nuclear reactor adopting a larger fuel size, thus it is possible to improve the safety and operational efficiency of the nuclear power plant.

[0030]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 5, for the method described in Claim 1, the nuclear reactor pressure vessel is of a type corresponding to a circulating system utilizing an internal pump. Consequently, it is possible to perform the change needed for increasing the efficiency of the internal pump so that the safety and economy can be improved.

[0031]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 6, for the method described in Claim 1, after the nuclear reactor pressure vessel is removed, the internal pump/control rod driving device's handler is removed from the opening on the roof; then, a new internal pump/control rod driving device's handler is installed through the opening on said roof. In this way the functions described in both Claim 1 and 4 can be realized.

[0032]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 7, after the fuel and inner structural parts are removed from the nuclear reactor pressure vessel and transferred to a maintenance building for storage, equipment for removing the nuclear reactor pressure vessel is set above the nuclear reactor building; from an opening formed beforehand on the roof of the nuclear reactor, said nuclear reactor pressure vessel is removed; on the other hand, a new nuclear reactor pressure vessel is installed through the opening of said roof; then, the fuel and inner structural parts are transferred from said maintenance building back into the nuclear reactor pressure vessel for reloading. Consequently, in the replacement operation there is no need to set an opening portion on the roof of the nuclear reactor building. As a result,

the number of operational steps is reduced and the operational period is shortened.

[0033]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 8, the device has the following parts: a frame set straddling the nuclear reactor building, accommodating equipment which is carried on the frame and which is connected by a third air lock to a removal chamber with a first air lock mounted on the upper side and a hoisting-up chamber with a second air lock mounted on the lower side, a crane which is set on the ceiling surface of said hoisting-up chamber and which hoists the nuclear reactor pressure vessel from said nuclear reactor building to the hoisting-up chamber, a flatcar which moves on the floor of said removal chamber and hoisting-up chamber, a tower crane which is carried on said frame and which lowers the nuclear reactor pressure vessel transferred to said removal chamber to outside said accommodating equipment, and a running flatcar which runs to transfer the nuclear reactor pressure vessel lowered by said tower crane to the maintenance building; while the nuclear reactor pressure vessel is removed from said nuclear reactor building to the maintenance building for disassembly, cleaning of pollution, repair, and storage, a new nuclear reactor pressure vessel for replacement is lowered in and installed in said nuclear reactor building. Consequently, when the nuclear reactor pressure vessel is removed from/replaced in the nuclear reactor building as a single body, there is no need to give special consideration to reinforcement of the nuclear reactor building. It is possible to prevent emission of the radioactive substance from the nuclear reactor building, and the exposure to radiation during operations can be reduced.

[0034]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 9, for the device described in Claim 8, the accommodating equipment is made up of a hoisting-up chamber alone. Consequently, there is no need to perform the operation for opening/closing the first air lock of the hoisting-out chamber, and the operation period needed for replacement of the nuclear reactor pressure vessel can be shortened.

[0035]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 10, for the device described in Claim 8, the accommodating equipment is made up of a hoisting-up chamber alone, and the tower crane is changed to a frame set on the ground surface. Consequently, in addition to the function of Claim 9, the operation for setting the tower crane becomes easier.

[0036]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 11, for the device described in Claim 10, a crawler crane is used instead of a tower crane. Consequently, the same function as Claim 10 can be realized.

[0037]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 12, for the device described in Claim 8, the accommodating equipment is made of a hoisting-up chamber alone, and the flatcar has a structure that allows it move from one end of the

frame to the other end. Consequently, in addition to the function of Claim 9, the operational range of the tower crane can be made narrower and the size of the equipment needed can be reduced.

[0038]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 13, for the device described in Claim 8 or 12, the flatcar moving on the frame is equipped with a pneumatic float-up-type moving device. Consequently, movement of the flatcar becomes easier.

[0039]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 14, for the device described in Claim 12, the hoisting-up chamber has an air dome structure; a gantry structural body is set inside it; and the crane for hoisting the nuclear reactor pressure vessel is mounted on the gantry structural body. Consequently, handling becomes simpler, the system becomes lighter, and the frame becomes smaller.

[0040]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 15, for the device described in Claim 8 or 14, the frame is of a running type, and the nuclear reactor pressure vessel is carried directly on the running flatcar by a crane mounted on the gantry structural body.

[0041]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 16, the device has the following parts: a crawler crane which hoists the nuclear reactor pressure vessel from a nuclear reactor building set on the ground surface, simple accommodating equipment which is set in said nuclear reactor building and has the nuclear reactor pressure vessel hoisted into it, and a running flatcar which directly carries the simple accommodating equipment with the nuclear reactor pressure vessel joined to it by said crawler crane from the nuclear reactor building and transfers it to the maintenance building; while the nuclear reactor pressure vessel is removed from said nuclear reactor building to the maintenance building for disassembly, cleaning of pollution, repair, and storage, a new nuclear reactor pressure vessel for replacement is lowered in and installed in said nuclear reactor building. Consequently, the nuclear reactor pressure vessel can be removed directly from the nuclear reactor building, and there is thus no need to have equipment for hoisting and moving the nuclear reactor pressure vessel by means of the frame. As a result, the preparation period for constructing the equipment can be cut.

[0042]

Application examples

Application Example 1 (with respect to method and device)

/6

Figure 1 is a flow chart illustrating in detail the various operation steps in Application Example 1 of the method for replacement of nuclear reactor pressure vessel in this invention. Figures 2-9 are flow chart diagrams illustrating in more detail the operation steps shown in Figure 1. Figure 10 is a diagram illustrating the configuration of Application Example 1 of the

device for replacement of nuclear reactor pressure vessel in this invention.

[0043]

As shown in Figure 10, in this application example, frame (2) is set straddling nuclear reactor building (1). On said frame (2), accommodating equipment (8) equipped with air locks (3), (4) and (5), flatcar (6), crane (7), etc. is carried. Said accommodating equipment (8) and opening portion (10) of roof (9) on reactor building (1) are bound to each other in an air-tight seal. Also, tower crane (11) is carried on frame (2). This equipment is used in performing the following remote operations: removal of nuclear reactor pressure vessel (12) from nuclear reactor building (1); setting it on flatcar (13) which runs on the ground surface; moving said flatcar (13) into maintenance building (14); transporting nuclear reactor pressure vessel (12) into operation pit (15) set in said maintenance building (14) to perform disassembly, cleaning of pollution, dissection, repair, maintenance operation, etc. On the other hand, new nuclear reactor pressure vessel (12) for replacement is set inside nuclear reactor building (1) through accommodating equipment (8).

[0044]

That is, on frame (2) set straddling nuclear reactor building (1), accommodating equipment (8) and tower crane (11) are carried. By means of flatcar (13) that runs on the ground surface, nuclear reactor pressure vessel (12) is transported from nuclear reactor building (1) to maintenance building (14) to perform the various operations of disassembly, cleaning of pollution, dissection, repair, maintenance operation, etc., while new nuclear reactor pressure vessel (12) for replacement is installed in nuclear reactor building (1).

[0045]

Accommodating equipment (8) is comprised of hoisting-up chamber (16) and hoisting-out chamber (17). The two chambers are connected to each other via air lock (4) (third air lock). Also, flatcar (6) with nuclear reactor pressure vessel (12), etc. carried on it can run freely on the floors of both chambers. On said flatcar (6), a supporting device (not shown in the figure) for holding nuclear reactor pressure vessel (12) is mounted. Air lock (5) (the second air lock) is attached on the lower surface of hoisting-up chamber (16), and it is bound in an air-tight seal to opening portion (10) of roof (9) of nuclear reactor building (1). Also, crane (7) for hoisting nuclear reactor pressure vessel (12) is mounted on the ceiling surface of hoisting up chamber (16). Air lock (3) (the first air lock) is mounted on the upper surface of hoisting-out chamber (17).

[0046]

In maintenance building (14), operation chamber (19) for performing such operations as disassembly, cleaning of pollution, dissection, repair, maintenance operation, etc. for nuclear reactor pressure vessel (12) is set. In said operation chamber (19), operation pit (15) and ceiling traveling crane (20) are set for loading nuclear reactor pressure vessel (12), and there is a water filling function in operation pit (15).

[0047]

Also, in maintenance building (14), there is fuel storing chamber (21) for temporary storage of the used fuel when the operation of replacement of nuclear reactor pressure vessel (12) is carried out. In Figure 10, the fuel transporting route from fuel storing loop (22) in nuclear reactor building (1) to fuel storing chamber (21) is not shown. In fuel storing chamber (21), fuel

storing pit (23) and ceiling crane (24) are set.

[0048]

In the following, the operation procedure of the method for replacement of nuclear reactor pressure vessel in Application Example 1 will be explained with reference to Figure 1. As shown in Figure 1, first of all, in step S1, the nuclear plant is shut down. Then, in step S2, preparation is carried out for removal of nuclear reactor pressure vessel (12). In step S3, the operation for opening of roof (9) of nuclear reactor building (1) is performed. Then, in step S4, after nuclear reactor pressure vessel (12) is removed, heat shielding body (25) is removed (step S5). Then, in step S6, the new nuclear reactor pressure vessel is installed step S7, new heat shielding body (25) is assembled. In steps S8 and S9, various members in nuclear reactor pressure vessel (12) are assembled, and the equipment for removing nuclear reactor pressure vessel (12) is withdrawn. Then, the fuel is reloaded in the core of nuclear reactor pressure vessel (12) (steps S10, S11).

[0049]

Figure 2 is a diagram illustrating the operation procedure for preparing removal of the nuclear reactor pressure vessel in step S2 shown in Figure 1.

[0050]

As shown in Figure 2, in step S21, the head portion of nuclear reactor pressure vessel (12) and the upper lid of nuclear reactor pressure vessel (12) are removed in order. In step S22, the internal structural members are removed. In step S23, the fuel is transferred from the core to the fuel storing rack of fuel storing pool (22). From the fuel storing rack, the fuel is accommodated

in a fuel transporting container, and, through a fuel transporting route, it is removed to fuel storing pit (23) of fuel storing chamber (21) in maintenance building (14) (step S24). Then, as all of the fuel in the core has been removed, the internal structural members are assembled in nuclear reactor pressure vessel (12) in step S25, and the upper lid is attached on nuclear reactor pressure vessel (12). In addition, in step S26, the equipment for removing the nuclear reactor pressure vessel is set above roof (9) of nuclear reactor building (1).

[0051]

Figure 3 is a diagram illustrating the operation procedure for opening the roof for the nuclear reactor pressure vessel in step S3 shown in Figure 1

[0052]

As shown in Figure 3, in step S31, temporary curing is performed on the upper surface of nuclear reactor well (26). Then, frame (2) is installed straddling nuclear reactor building (1). Accommodating equipment (8) is installed on said frame. Installation is carried out such that the center of air lock (5) on the lower surface of hoisting-up chamber (16) inside accommodating container (8) is positioned right above the central axis of nuclear reactor pressure vessel (12) set inside nuclear reactor building (1). Then, air lock (5) is opened, and the lower surface of hoisting-up chamber (16) and roof (9) of nuclear reactor building (1) are bound to each other in an air-tight seal (step S32). Then, the hoisting fixture is installed at the center of roof (9) corresponding to air lock (5), and crane (7), set on the ceiling of hoisting-up chamber (16), and said hoisting fixture are set in a hoisting state by wires (step S34). Roof (9) is cut for a size corresponding to the opening of air lock (5) by means of a laser cutter or the like (step S35).

[0053]

Upon the end of cutting and removal of a block of a size appropriate for passage of /7 nuclear reactor pressure vessel (12) from roof (9), the block is hoisted by crane (7) in hoisting-up chamber (16), and air lock (5) is closed. Then, air lock (4) is opened and flatcar (6) is moved from hoisting-out chamber (17) to hoisting-up chamber (16), and the block cut from roof (9) is lowered on flatcar (6) for curing. Then, flatcar (6) is moved to hoisting-out chamber (17) and air lock (4) is closed. After that, air lock (3) on the ceiling surface of hoisting-out chamber (17) is opened, the hook of tower crane (11) is lowered in hoisting-out chamber (17), the hoisting fixture of the block of roof (9) that had been removed and the hook of tower crane (11) are connected to each other by a wire, the block is hoisted out from hoisting-out chamber (17) and lowered onto flatcar (13) running on the ground surface. Said running flatcar (13) is driven into operation chamber (19) inside maintenance building (14) and, by means of ceiling running crane (20), the block cut out from roof (9) is lowered from running flatcar (13) to operation pit (15) or the like. Then, the aforementioned block is disassembled by a cutter or the like, and the obtained pieces are packed in a drum can for storage and are stored at a waste-storing site (step S36).

[0054]

Then, in a procedure reverse to that for removal of the block cut out from roof (9), a lid device that can be opened/closed is transported to opening portion (10) of roof (9) and is installed on roof (9) (step S37). Then, in step S38, temporary curing is performed for the upper surface of nuclear reactor well (26).

[0055]

Figure 4 is a diagram illustrating the procedure of the operation for removing the nuclear reactor pressure vessel in step S4 shown in Figure 1.

[0056]

As shown in Figure 4, air lock (5) is opened, the open/close type lid device is opened, the hoisting fixture is mounted on the hook of crane (7) set on the ceiling surface of hoisting-up chamber (16) and is lowered into nuclear reactor building (1), and the hoisting fixture is bound to the lid of nuclear reactor pressure vessel (12) (step S41). Then, the pipeline connected to nuclear reactor pressure vessel (12) is cut at the nozzle portion (water is drained from nuclear reactor well (26) and nuclear reactor pressure vessel (12) before cutting), the blocking member between nuclear reactor pressure vessel (12) and the nuclear reactor accommodating container is withdrawn, and nuclear reactor pressure vessel (12) is cut off from pedestal (27) (steps S42-S44).

[0057]

Upon end of the operation for cutting nuclear reactor pressure vessel (12) from said pedestal (27), said nuclear reactor pressure vessel (12) is hoisted by crane (7) into hoisting-up chamber (16) and air lock (5) is closed. Then, air lock (4) is opened and flatcar (6) is moved from hoisting-out chamber (17) to hoisting-up chamber (16). Said nuclear reactor pressure vessel (12) is lowered onto flatcar (16) and the hoisting fixture is removed to perform curing. Said flatcar (6) is driven to hoisting-out chamber (17) and air lock (4) is closed. Then, air lock (3) on the ceiling surface of hoisting-out chamber (17) is opened, the hoisting fixture is mounted on the hook of tower crane (11), lowered into hoisting-out chamber (17), and bound to the lid of nuclear reactor

pressure vessel (12). Then, nuclear reactor pressure vessel (12) is hoisted out from hoisting-out chamber (17) and lowered onto running flatcar (13) that runs on the ground surface (step S45).

[0058]

In step S46, running flatcar (13) is driven to operation chamber (19) inside maintenance building (14), nuclear reactor pressure vessel (12) is lowered from running flatcar (13) to operation pit (15) by means of ceiling crane (20), and it is fixated on the floor of operation pit (15) by a supporting device. Then, in step S47, water is filled in operation pit (15) and opening/closing of the upper lid of nuclear reactor pressure vessel (12) is carried out by means of an automatic machine. Then, the welded internal structural members are cut in water by means of a cutter using a laser beam. The internal structural members are removed from nuclear reactor pressure vessel (12) and are transported in water into operation pit (28). When the interior of nuclear reactor pressure vessel (12) becomes empty, a laser beam is used to clean pollution from the surface of nuclear reactor pressure vessel (12). In this method of cleaning pollution by laser, it is especially effective to selectively remove cobalt 60, an isotope of cobalt, by means of the difference in the vapor pressure. Upon the end of cleaning of pollution of nuclear reactor pressure vessel (12), water gate (29) between operation pit (15) and operation pit (28) is closed, and water is exhausted from operation pit (15). Then, the lid is covered on the opening portion of the nozzle portion of nuclear reactor pressure vessel (12).

[0059]

Then, for the internal structural members temporarily set in operation pit (28), a laser beam is used to clean pollution and cutting to reduce the volume. After reduction of volume, the

internal structural members are accommodated again in nuclear reactor pressure vessel (12), and nuclear reactor pressure vessel (12) becomes a low-pollution waste container.

[0060]

Figure 5 is a diagram illustrating the operation procedure of removal of the heat shielding body in step S5 shown in Figure 1.

[0061]

As shown in Figure 5, in steps S51 and S52, air lock (5) of hoisting-up chamber (16) is opened, the open/close type lid device is opened, the hoisting fixture is mounted on the hook of crane (7) set on the ceiling surface of hoisting-up chamber (16) and is lowered in nuclear reactor building (1), the hoisting fixture is bound to heat shielding body (25), and heat shielding body (25) is cut off from pedestal (27). Upon the end of the cutting operation, crane (7) is used for hoisting into hoisting-up chamber (16), and air lock (5) is closed.

[0062]

Then, in step S53, air lock (4) is opened, flatcar (6) is driven from hoisting-out chamber (17) to hoisting-up chamber (16), heat shielding body (25) is lowered onto flatcar (6), the hoisting fixture is removed and curing is performed, flatcar (6) is driven to hoisting-out chamber (17), and air lock (4) is closed.

[0063]

Then, in step S54, air lock (3) on the ceiling of hoisting-out chamber (17) is opened, the hoisting fixture is mounted on the hook of tower crane (11) and is lowered to hoisting-out chamber (17), the hoisting fixture is bound to heat shielding body (25), nuclear reactor pressure vessel (12) is hoisted out from hoisting-out chamber (17), and it is lowered on running flatcar (13) running on the ground surface. After said running flatcar (13) is driven to operation chamber (19) of maintenance building (14), heat shielding body (25) is lowered from running flatcar (13) into operation pit (15) by ceiling running crane (20); it is disassembled by a cutter using a laser beam, and the disassembled pieces are packed in a drum can for storage at a waste-storing site (step S55).

[0064]

Figure 6 is a diagram illustrating the procedure of operation of installation of the new pressure vessel in step S6 shown in Figure 1.

/8

[0065]

As shown in Figure 6, in step S61, the frame for shielding wall and the structural unit on factory-manufactured nuclear reactor pressure vessel (12) for replacement (the new nuclear reactor pressure vessel) is moved by means of running flatcar (13) into the range that allows hoisting of tower crane (11); then the hoisting fixture mounted on the hook of said tower crane (11) is joined to nuclear sector pressure vessel (92), the frame of the heat shielding wall and the structural unit, it is hoisted and lowered from air lock (3) by the opening in the hoisting-out chamber (17) onto flatcar (6) within hoisting-out chamber (17). In this way nuclear reactor

pressure vessel (12) for replacement is taken from running flatcar (13) into nuclear reactor building (1) (step S62). Then, the aforementioned hoisting fixture is removed and the hook of tower crane (11) is hoisted out from hoisting-out chamber (17).

[0066]

After air lock (3) is closed, air lock (4) is opened, and flatcar (6) is driven from hoisting-out chamber (17) to hoisting-up chamber (16). The hoisting fixture mounted on the hook of crane (7) set on the ceiling surface of said hoisting-up chamber (16) is bound to nuclear reactor pressure vessel (12), the frame for the heat shielding wall, and the structural unit for replacement. After minor lifting, flatcar (6) is moved from hoisting-up chamber (16) to hoisting-out chamber (17).

[0067]

Then, air lock (4) is closed, air lock (5) and open/close type lid device is opened, and nuclear reactor pressure vessel (12), the frame for heat shielding wall and the structural unit for replacement hung from crane (7) are lowered into nuclear reactor building (1). Then, nuclear reactor pressure vessel (12), the frame for heat shielding wall, and the structural unit for replacement are lowered onto pedestal (27), and they are fixated (step S63). Upon end of the fixating operation, the hoisting fixture is removed, the hook of crane (7) is pulled up into hoisting-up chamber (16), and air lock (5) and open/close type lid device is closed (step S64). Then, accommodating equipment (8) and tower crane (11) are withdrawn from frame (2). Then, frame is disassembled and withdrawn.

[0068]

Figure 7 is a diagram illustrating the procedure of operation for binding the various members to the nuclear reactor pressure vessel in step S8 as shown in Figure 1. As shown in Figure 7, in step S71 the pipeline is connected by welding to the nozzle of nuclear reactor pressure vessel (12) for replacement, and concrete for heat shielding is formed on the frame for heat shielding wall and structural unit. Then, in step S72 the sealing member between nuclear reactor pressure vessel (12) and the nuclear reactor accommodating container is connected to the sealing bellows. In step S73, control rod driving mechanism (CRD) is mounted on nuclear reactor pressure vessel (12), and, finally, in step S74 a pressure resistance test of nuclear reactor pressure vessel (12) is carried out.

[0069]

Figure 8 is a diagram illustrating the procedure of operation for withdrawing the equipment for removing the nuclear reactor pressure vessel in step S9 shown in Figure 1. As shown in Figure 8, after opening portion (10) of roof (9) of nuclear reactor building (1) is closed by the lid in step S81, the air tight seal between roof (9) of nuclear reactor building (1) and the equipment for removing nuclear reactor pressure vessel (12) is released in step S82. That is, in step S82, the air tight seal between the lower surface of hoisting-up chamber (16) and roof (9) of nuclear reactor building (1) is released. Then, in step S83, the removal equipment, such as wire, etc., for nuclear reactor pressure vessel (12) is withdrawn from above roof (9) of nuclear reactor building (1).

[0070]

Figure 9 is a diagram illustrating the procedure of fuel reloading in step S10 in Figure 1.

As shown in Figure 9, after the upper lid of nuclear reactor pressure vessel (12) is removed in step S91, the internal structural members are removed from nuclear reactor pressure vessel (12) in step S92, and temporarily set inside the nuclear reactor pit. Then, water is filled in nuclear reactor well (26), and the used fuel is transported from fuel storing pit (23) of fuel storing chamber (21) in maintenance building (14) through a fuel transporting route to the fuel storing rack of fuel storing pool (22) for accommodating in the fuel transporting container (step S93).

[0071]

Then, in step S94, fuel is loaded from said fuel storing rack into the core of the nuclear reactor by a fuel handler. Then, upon end of loading of the fuel and loading of the control rods, in step S95, the internal structural members are mounted in nuclear reactor pressure vessel (12). In step S96, the upper lid is mounted on nuclear reactor pressure vessel (12). Then, in step S97, the head portion of the nuclear reactor accommodating container is installed, and the replacement operation of nuclear reactor pressure vessel (12) ends.

[0072]

In Application Example 1, by using frame (2) straddling nuclear reactor building (1), accommodating equipment (8) for removing and accommodating nuclear reactor pressure vessel (12) carried on said frame, tower crane (11), running flatcar (13) that runs on the ground surface, maintenance building (14) for performing disassembly, cleaning of pollution, dissection, repair, maintenance operation, etc. for nuclear reactor pressure vessel (12), etc., it is possible to perform

replacement of nuclear reactor pressure vessel (12) in a short time free of diffusion of the radioactive substances to the surrounding environment, and it is possible to safely keep the replaced large-sized structural members for a long time.

[0073]

In Application Example 1, tower crane (11) is carried on frame (2). However, the configuration is not limited to that. It is also possible to set the tower crane and crawler crane (30) (see Figure 12) on the ground surface. It is also possible to realize the same effect as in Application Example 1 by means of these cranes.

[0074]

Also, in the formation of the opening on roof (9) of nuclear reactor building (1), a cutter using a laser beam or the like is used. In this case, examples of the lasers that may be used include a visible semiconductor laser, YAG laser, copper vapor laser, etc.

[0075]

Figure 11 is a diagram illustrating the configuration of a modified example of Application Example 1 of the device for replacement of the nuclear reactor pressure vessel in this invention.

[0076]

In this modified example, accommodating equipment (31) carried on frame (2) is made up only of hoisting-up chamber (16) of Application Example 1. In this modified example there is no need to perform the open/close operation of air lock (3) of hoisting-out chamber (17) as would

be needed in Application Example 1, and it is thus possible to shorten the operational period needed for replacement of nuclear reactor pressure vessel (12).

[0077]

Application Example 2 (for the device)

Figure 12 is a diagram illustrating Application Example 2 of the device for replacement/9 of nuclear reactor pressure vessel. The same part numbers as those in Application Example 1 are adopted here for Application Example 2. This is also true for the other application examples and modified examples to be presented below.

[0078]

Application Example 2 differs from Application Example 1 in that accommodating equipment (31) carried on frame (2) is comprised of hoisting-up chamber (16) alone. Said flatcar (6) has a structure that allows it to run from within hoisting-up chamber (16) to the end portion of frame (2). Also, tower crane or crawler crane (30) is set on the ground surface.

[0079]

This application example differs from Application Example 1 further in that it has the following function: after air lock (5) of hoisting-up chamber (16) is closed and air lock (4) is opened, nuclear reactor pressure vessel (12) is transported on flatcar (6); then, flatcar (6) is driven from within hoisting-up chamber (16) to the end portion of frame (2) to transport nuclear reactor pressure vessel (12), etc.

[0080]

The effects of the device in Application Example 2 are the same as those in Application Example 1. However, in this case the open/close operation of air lock (3) of hoisting-out chamber (17), as would be needed in Application Example 1, is not needed. Consequently, the operation period can be shortened. Also, as flatcar (6) is driven to the end portion of frame (2) to transport nuclear reactor pressure vessel (12) or the like, it is possible to reduce the operational range of tower crane or crawler crane (30), and it is possible to reduce the size of the equipment needed. The other structural features, operational features, and effects are the same as those in Application Example 1 and will not be explained again. Also, for the application examples and modified examples to be presented below, the structure, function, and effects are also the same as those in Application Example 1; and they also will not be explained again.

[0081]

Also, in Application Example 2, if flatcar (6) is equipped with a pneumatic-float-type moving device, it is possible to make the movement in a pneumatic floating state. It is thus possible to transport nuclear reactor pressure vessel (12) or the like while flatcar (6) floats over the floor of frame (2) and accommodating equipment (31). As a result, the power needed for driving flatcar (6) can be reduced, flatcar (6) can be made lighter, and the structure of frame (2) can be made smaller. In this case, the aforementioned pneumatic-floating-type moving device makes use of pneumatic pressure to inflate a diaphragm to form a pressure region such that a thin air film is formed between the diaphragm and the floor surface while the control air leaks to the atmosphere. By means of this air film, the workpiece can be lifted so that there is no friction between the workpiece and the floor. Consequently, only a small force can drive the flatcar to

move in any direction.

[0082]

Application Example 3 (for the device)

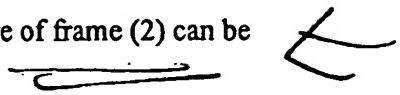
Figure 13 is a diagram illustrating the configuration of Application Example 3 of the device for replacement of nuclear reactor pressure vessel in this invention. In Application Example 3, the accommodating equipment carried on frame (2) is made up of a hoisting-up chamber alone. This hoisting-up chamber is comprised of air dome (31). Also, flatcar (6) can run from one end portion to the other end portion of frame (2), and it can move in the pneumatic floating state on frame (2) and on the floor of hoisting-up chamber (16) of accommodating equipment (33) just as in the modified example of Application Example 2. In addition, gantry structural body (32) is set on frame (2), and crane (7) for hoisting nuclear reactor pressure vessel (12) or the like is mounted on said gantry structural body (32). The entirety of gantry structural body (32) is surrounded by air dome (31). Air locks (34) and (35) are set on the side surface of lower surface of said air dome (31) to form the hoisting-up chamber. Crawler crane (30) is set on the ground surface.

[0083]

The functions of Application Example 3 are similar to the functions of Application Example 2. However, this application example differs from Application Example 2 in that it has the following function: after air lock (35) of air dome (31) is closed and air lock (34) is opened, nuclear reactor pressure vessel (12) or the like carried on flatcar (6) is moved from within air dome (31) to the end portion of frame (2), and flatcar (6) is floated by pneumatic pressure to

transport nuclear reactor pressure vessel (12) or the like.

[0084]

In Application Example 3 of the device, the hoisting-up chamber is made up of air dome (31). Consequently, handling is simple, the device is light, and the structure of frame (2) can be ~~made small.~~ 

[0085]

Application Example 4 (for device)

Figure 14 is a diagram illustrating the structure of the main portion of Application Example 4 of the device for replacement of nuclear reactor pressure vessel in this invention. In Application Example 4, the frame is gantry crane (36) instead of frame (2) in Application Example 1. With nuclear reactor pressure vessel (12) hoisted in accommodating equipment (33), said gantry crane (36) runs on guide rail (37), and nuclear reactor pressure vessel (12) is directly lifted and lowered onto running flatcar (13). Also, accommodating equipment (33) that forms ~~hoisting-up chamber (16)~~  is carried on gantry crane (36), and gantry structural body (32) with crane (7) mounted on it is set in air dome (31).

[0086]

In the following, the function of Application Example 4 will be explained.

[0087]

In order to enable gantry crane (36) straddling on nuclear reactor building (1) to run,

guide rail (37) is laid along nuclear reactor building (1). On said guide rail (37), gantry crane (36) is assembled at a position that straddles nuclear reactor building (1). Upon end of the assembly operation, gantry crane (36) is driven to move such that the center of air lock (35) formed on the lower surface of hoisting-up chamber (16) is positioned right above the central axis of nuclear reactor pressure vessel (12) set in nuclear reactor building (1). Then, air lock (35) is opened, and the lower surface of hoisting-up chamber (16) and roof (9) of nuclear reactor building (1) are connected to each other with an air tight seal.

[0088]

Then, a hoisting fixture is mounted at the center of roof (9) corresponding to air lock (35). While crane (7) mounted on gantry structural body (32) of hoisting-up chamber (16) and said hoisting fixture are hoisted by wires, a block having a size matching the opening of air lock (35) is cut out from roof (9) by a cutter using a laser beam. Upon the end of the operation of cutting of the block of a size that allows passage of nuclear reactor pressure vessel (12) from roof (9), the block is lifted by crane (7) in hoisting-up chamber (16). Then, opening portion (10) on roof (9) is closed by a lid with an air cushion structure. The lower surface of hoisting-up chamber (16) and roof (9) of nuclear reactor building (1) is released, and air lock (35) is closed.

[0089]

Then, gantry crane (36) is driven to move above running flatcar (13) that runs on the ground surface, and the block is lowered on the running flatcar (13). Then, running flatcar (13) is driven to operation chamber (19) inside maintenance building (14). Using ceiling running crane (20), the block of roof (9) that has been cut out is lowered from running flatcar (13) into

operation pit (15) or the like. Said block is disassembled by a cutter using a laser beam or the like, and the pieces obtained are packed in a drum can for storage at a waste-storing site. Then, in the same operation as in Application Example 1, nuclear reactor pressure vessel (12) and heat shielding body (25) are carried out. On the other hand, the operation for installing the new nuclear reactor pressure vessel is carried out in a procedure reverse to the aforementioned one.

[0090]

According to Application Example 4 of the device, gantry crane (36) runs on guide rail (37), and nuclear reactor pressure vessel (12) or the like is directly lowered onto running flatcar (13) and is carried on it. Consequently, tower crane (11) used in Application Example 1 is not needed in this case and, as gantry crane (36) can be assembled at a site where nuclear reactor building (1) is absent, the assembly operation can be carried out easily and the operational efficiency can be increased.

[0091]

Application Example 5 (for the device)

Figure 15 is a diagram illustrating the configuration of Application Example 5 of the device for nuclear reactor pressure vessel in this invention.

[0092]

In Application Example 5, frame (2) used in Application Example 1 is not used. Instead, crawler crane (30) is set on the ground surface. By means of crane (30), nuclear reactor pressure vessel (12) is hoisted into simple accommodating equipment (38), and nuclear reactor pressure vessel (12) is lowered directly onto running flatcar (13) and is carried on it. Also, simple accommodating equipment (38) has the function of the air dome.

[0093]

In the following, the function of Application Example 5 will be explained.

[0094]

This application example differs from Application Example 1 in which frame (2) and accommodating equipment (8) are used and opening portion (10) is formed on roof (9) of nuclear reactor building (1), in that simple accommodating equipment (38) is hoisted by crawler crane (30) and is bound on roof (9), and air is injected into simple accommodating equipment (38) to make it stand alone. Then, the hoisting fixture of crawler crane (30) is lowered in simple accommodating equipment (38); this hoisting fixture and the hoisting fixture mounted on roof (9) are bound to each other by wires. Then, in the same way as in Application Example 4, the cutting operation is carried out and simple lid (39) is mounted on opening portion (10). On simple lid (39), the binding mechanism with simple accommodating equipment (38) and a foldable open/close mechanism are attached. Also, in order to facilitate handling, an air cushion structure is adopted. Consequently, by making simple lid (39) and simple accommodating equipment (38) bound to each other and separated from each other, the operation of removal of nuclear reactor

pressure vessel (12) and heat shielding body (25) and installation of the new nuclear reactor pressure vessel is carried out by crawler crane (30).

[0095]

In Application Example 5 of the device with the aforementioned configuration, binding/separation of simple lid (39) and simple accommodating equipment (38) are carried out by crawler crane (30), and nuclear reactor pressure vessel (12) and heat shielding body (25) are removed directly from nuclear reactor building (1). Consequently, there is no need to have equipment for hoisting nuclear reactor pressure vessel (12) using frame (2), and it is thus possible to cut the cost of equipment and to shorten the period of setup preparation for the equipment.

[0096]

Application Example 2 (for the method)

Figure 16 is a flow chart illustrating the procedure of operation of Application Example 2 of the method for replacement of nuclear reactor pressure vessel in this invention.

[0097]

With regard to Figure 16, the same operation steps as those shown in Figure 1 will not be explained again. That is, the operation steps P1-P5 and P8-P11 shown in Figure 16 are the same as their counterparts in Figure 1, and will not be explained again.

[0098]

Application Example 2 differs from Application Example 1, in which the new heat

shielding body is assembled inside nuclear reactor building (1), in that the inner diameter of the new heat shielding body is selected to be larger than the outer diameter of the tip of the nozzle of the new nuclear reactor pressure vessel, and the new heat shielding body is installed as a single body.

[0099]

As shown in Figure 16, in step P6, the new heat shielding body as a single body is lowered through opening portion (10) on roof (9) of nuclear reactor building (1) and is fixated on pedestal (27). Then, in the same way in step P7, the new nuclear reactor pressure vessel is installed through opening portion (10) on roof (9) of nuclear reactor building (1) inserted in said new heat shielding body, and fixated on pedestal (27).

[0100]

In Application Example 2 of the method, in addition to the effects of said Application Example 1, there is also the following effect: the new heat shielding body as a single body is lowered into nuclear reactor building (1) for installation. Consequently, the operation period can be further shortened.

[0101]

Also, in this application example one may swap the order in installing the new heat shielding body and the new nuclear reactor pressure vessel into nuclear reactor building (1). The effect is the same.

[0102]

Application Example 3 (for the method)

Figure 17 is a flow chart illustrating the procedure of operation of Application Example 3 of the method for replacement of the nuclear reactor pressure vessel in this invention.

[0103]

The operation steps shown in Figure 17 are identical to those in Figure 1 and will not be explained again. This rule is also observed in the later application examples.

[0104]

In Application Example 3, the operation steps of removing the control rod driving device's handler, remodeling of the pedestal, and installation of the new internal pump/control rod driving device's handler are added to the steps in Application Example 1 while the assembly step of the new heat shielding body is deleted. In this application example, the new nuclear reactor pressure vessel corresponds to the internal pump and hence there is no need to set the heat shielding body.

[0105]

As shown in Figure 17, in step P25, heat shielding body (25) is removed. Then, in step P26, the control rod driving device's handler is removed. Then, in step P27, pedestal (27) is remodeled to be able to handle the internal pump. After that, in step P28, the new internal pump/control rod driving device's handler are installed, and, in step P29, the new nuclear reactor pressure vessel with the internal pump mounted on it is installed.

[0106]

In Application Example 3 of this invention, it is possible to change to a circulating system utilizing an internal pump for better safety, and it is possible to shorten the fuel exchange period. Also, it is possible to change to a core adopting a large-size fuel and, at the same time, to improve the safety and operation efficiency of the nuclear plant.

/11

[0107]

Application Example 4 (for the method)

Figure 18 is a flow chart illustrating the procedure of operation in Application Example 4 of the method for replacement of the nuclear reactor pressure vessel in this invention.

[0108]

In Application Example 4, the operation of removal of the heat shielding body and assembly of the new heat shielding body is deleted from the operation procedure in Application Example 1. The nuclear reactor pressure vessel adopted in this application example is of a type corresponding to a circulating system by means of an internal pump.

[0109]

In Application Example 4 of this invention, it is possible to improve the safety and economy by adopting changes corresponding to an increase in the efficiency of the internal pump.

[0110]

Application Example 5 (for the method)

Figure 19 is a flow chart illustrating the procedure of operation in Application Example 5 of the method for replacement of the nuclear reactor pressure vessel in this invention.

[0111]

In Application Example 5, with respect to the operation procedure of Application Example 1, the operation of removal of the internal pump/control rod driving device's handler and installation of the new internal pump/control rod driving device's handler is added. On the other hand, the operation of removal of the heat shielding body and assembly of the new heat shielding body is deleted. Also, as nuclear reactor pressure vessel (12) corresponds to the internal pump, there is no need to set the heat shielding body.

[0112]

As shown in Figure 19, in step P54, nuclear reactor pressure vessel (12) is removed. Then, in step P55, the internal pump/control rod driving device's handler is removed. In step P56, the new internal pump/control rod driving device's handler is installed. Then, in step P57, the new nuclear reactor pressure vessel is taken in.

[0113]

In Application Example 4 of the method, both the effects of Application Example 1 and Application Example 3 can be realized.

[0114]

Application Example 6 (for the method)

Figure 20 is a flow chart illustrating the procedure of operation in Application Example 6 of the method for replacement of the nuclear reactor pressure vessel in this invention.

[0115]

In Application Example 6, from the operation procedure in Application Example 1, the operation of setting opening portion (10) on roof (9), the operation of removal of heat shielding body (25), and the operation of assembly of the new heat shielding body are deleted. Also, as nuclear reactor pressure vessel (12) corresponds to the internal pump, there is no need to set the heat shielding body. Also, as opening portion (10) on roof (9) is formed when the nuclear reactor is constructed, there is no step of formation of the opening.

[0116]

In Application Example 6 of the method with the aforementioned configuration, as there is no need to form opening portion (10) on roof (9), it is possible to reduce the number of steps of operation, and it is possible to shorten the operation period.

[0117]

Effect of the invention

According to the method for replacement of nuclear reactor pressure vessel described in Claim 1 of this invention, after the fuel and inner structural parts are removed from the nuclear reactor pressure vessel and transferred to a maintenance building for storage, equipment for

removing the nuclear reactor pressure vessel is set above the nuclear reactor building; an opening is formed on the roof of the nuclear reactor building; from the opening, said nuclear reactor pressure vessel is removed; on the other hand, a new nuclear reactor pressure vessel is installed through the opening of said roof; then, the fuel and inner structural parts are transferred from said maintenance building back into the nuclear reactor pressure vessel for reloading. Consequently, the nuclear reactor pressure vessel can be replaced in a short time free of diffusion of the radioactive substance to the surrounding [area], and after replacement the large structural members can be safely stored for a long time.

[0118]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 2, the pressure vessel and heat shielding body of the nuclear reactor are sequentially removed from the opening; on the other hand, a new heat shielding body and a new nuclear reactor pressure vessel are installed through the opening of said roof. Consequently, it is possible to replace the nuclear reactor pressure vessel and heat shielding body in a short time free of diffusion of the radioactive substance to the surrounding [area].

[0119]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 3, for the method described in Claim 2, the inner diameter of the new heat shielding body is selected to be larger than the outer diameter of the nozzle portion of the new nuclear reactor pressure vessel. Consequently, it is possible to further shorten the time of operation for lowering the new heat shielding body as a single body into the nuclear reactor building for replacement.

[0120]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 4, for the method described in Claim 1, after the nuclear reactor pressure vessel is removed, the control rod driving device's handler is removed from the opening on the roof; then, the pedestal is remodeled, and a new internal pump/control rod driving device's handler is installed through the opening on said roof. Consequently, it is possible to change to a circulating system utilizing an internal pump with even higher safety, and it is possible to shorten the fuel exchange period. Also, it allows a change to a nuclear reactor adopting a larger fuel size, and it is possible to improve the safety and operational efficiency of the nuclear power plant.

[0121]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 5, for the method described in Claim 1, the nuclear reactor pressure vessel is of a type corresponding to a circulating system utilizing an internal pump. Consequently, it is possible to perform the change needed for increasing the efficiency of the internal pump so that safety and economy can be improved.

[0122]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 6, for the method described in Claim 1, after the nuclear reactor pressure vessel is removed, the internal pump/control rod driving device's handler is removed from the opening on the roof; then, a new internal pump/control rod driving device's handler is installed through the opening on said roof. In this way the functions described in both Claim 1 and 4 can be realized.

[0123]

According to the method for replacement of nuclear reactor pressure vessel described in Claim 7, after the fuel and inner structural parts are removed from the nuclear reactor pressure vessel and transferred to a maintenance building for storage, equipment for removing the nuclear reactor pressure vessel is set above the nuclear reactor building; from an opening formed beforehand on the roof of the nuclear reactor, said nuclear reactor pressure vessel is removed; on the other hand, a new nuclear reactor pressure vessel is installed through the opening of said roof; then, the fuel and inner structural parts are transferred from said maintenance building back into the nuclear reactor pressure vessel for reloading. Consequently, in the replacement operation there is no need to set an opening portion on the roof of the nuclear reactor building. As a result, the number of operation steps is reduced and the operation period is shortened.

[0124]

According to the device for replacement of nuclear reactor pressure vessel described in/12 Claim 8, the device has the following parts: a frame set straddling the nuclear reactor building, accommodating equipment which is carried on the frame and which is connected by a third air lock to a removal chamber with a first air lock mounted on the upper side and a hoisting-up chamber with a second air lock mounted on the lower side, a crane which is set on the ceiling surface of said hoisting-up chamber and which hoists the nuclear reactor pressure vessel from said nuclear reactor building to the hoisting-up chamber, a flatcar which moves on the floor of said removal chamber and hoisting-up chamber, a tower crane which is carried on said frame and which lowers the nuclear reactor pressure vessel transferred to said removal chamber to outside said accommodating equipment, and a running flatcar which runs to transfer the nuclear reactor

pressure vessel lowered by said tower crane to the maintenance building; while the nuclear reactor pressure vessel is removed from said nuclear reactor building to the maintenance building for disassembly, cleaning of pollution, repair, and storage, a new nuclear reactor pressure vessel for replacement is lowered and installed in said nuclear reactor building. Consequently, when the nuclear reactor pressure vessel is taken into/from the nuclear reactor building as a single body, there is no need to give special consideration to reinforcement of the nuclear reactor building. It is possible to prevent emission of the radioactive substance from the nuclear reactor building, and the exposure to radiation during operation can be reduced.

[0125]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 9, for the device described in Claim 8, the accommodating equipment is made up of a hoisting-up chamber alone. Consequently, there is no need to perform the operation for opening/closing the first air lock of the hoisting-out chamber, and the operation period needed for replacement of the nuclear reactor pressure vessel can be shortened.

[0126]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 10, for the device described in Claim 8, the accommodating equipment is made of a hoisting-up chamber alone, and the tower crane is changed to a frame set on the ground surface. Consequently, in addition to the function of Claim 9, the operation for setting the tower crane becomes easier.

[0127]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 11, for the device described in Claim 10, a crawler crane is used instead of the tower crane. Consequently, the same function as Claim 10 can be realized.

[0128]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 12, for the device described in Claim 8, the accommodating equipment is made of a hoisting-up chamber alone, and the flatcar has a structure that allows it to move from one end of the frame to the other end. Consequently, in addition to the function of Claim 9, the operation range of the tower crane can be made narrower and the size of the equipment needed can be reduced.

[0129]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 13, for the device described in Claim 8 or 12, the flatcar moving on the frame is equipped with a pneumatic float-up-type moving device. Consequently, movement of the flatcar becomes easier.

[0130]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 14, for the device described in Claim 12, the hoisting-up chamber has an air dome structure; a gantry structural body is set inside it; and the crane for hoisting the nuclear reactor

pressure vessel is mounted on the gantry structural body. Consequently, handling becomes simpler, the system becomes lighter, and the frame becomes smaller.

[0131]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 15, for the device described in Claim 8 or 14, the frame is of a running type, and the nuclear reactor pressure vessel is carried directly on the running flatcar by a crane mounted on the gantry structural body.

[0132]

According to the device for replacement of nuclear reactor pressure vessel described in Claim 16, the device has the following parts: a crawler crane which hoists the nuclear reactor pressure vessel from a nuclear reactor building set on the ground surface, a simple accommodating equipment which is set in said nuclear reactor building and has the nuclear reactor pressure vessel hoisted into it, and a running flatcar which directly carries the simple accommodating equipment with the nuclear reactor pressure vessel joined to it by said crawler crane from the nuclear reactor building and transfers it to the maintenance building; while the nuclear reactor pressure vessel is removed from said nuclear reactor building to the maintenance building for disassembly, cleaning of pollution, repair, and storage, a new nuclear reactor pressure vessel for replacement is lowered and installed in said nuclear reactor building. Consequently, the nuclear reactor pressure vessel can be removed directly from the nuclear reactor building, and there is thus no need to have equipment for hoisting and moving the nuclear reactor pressure vessel by means of the frame. As a result, the operation preparation period for

constructing the equipment can be cut.

Brief description of the figures

Figure 1 is a flow chart illustrating the procedure of operation of Application Example 1 of the method for replacement of the nuclear reactor pressure vessel in this invention.

Figure 2 is a flow chart illustrating the procedure of operation for preparing removal of the nuclear reactor pressure vessel in step S2 shown in Figure 1.

Figure 3 is a flow chart illustrating the procedure of operation for the formation of an opening on the roof of the nuclear reactor building in step S3 shown in Figure 1.

Figure 4 is a flow chart illustrating the procedure of operation for removal of the nuclear reactor pressure vessel in step S4 shown in Figure 1.

Figure 5 is a flow chart illustrating the procedure of operation for removal of the heat shielding body in step S5 shown in Figure 1.

Figure 6 is a flow chart illustrating the procedure of operation for removal of the new pressure vessel in step S6 in Figure 1.

Figure 7 is a flow chart illustrating the procedure of operation for binding the various members in the nuclear reactor pressure vessel in step S8 shown in Figure 1.

Figure 8 is a flow chart illustrating the procedure of operation for withdrawing the equipment for removal of the nuclear reactor pressure vessel in step S9 shown in Figure 1.

Figure 9 is a flow chart illustrating the procedure of operation for reloading of fuel in step S10 shown in Figure 1.

Figure 10 is a diagram illustrating the configuration of Application Example 1 of the device for replacement of nuclear reactor pressure vessel in this invention.

Figure 11 is a diagram illustrating the configuration of a modified example of Application Example 1 of the device for replacement of nuclear reactor pressure vessel in this invention.

Figure 12 is a diagram illustrating the configuration of Application Example 2 of the device for replacement of nuclear reactor pressure vessel in this invention.

Figure 13 is a diagram illustrating the configuration of Application Example 3 of the device for replacement of nuclear reactor pressure vessel in this invention.

Figure 14 is a diagram illustrating the configuration of Application Example 4 of the device for replacement of nuclear reactor pressure vessel in this invention.

Figure 15 is a diagram illustrating the configuration of Application Example 5 of the device for replacement of nuclear reactor pressure vessel in this invention. /13

Figure 16 is a flow chart illustrating the procedure of operation in Application Example 2 of the method for replacement of nuclear reactor pressure vessel in this invention.

Figure 17 is a flow chart illustrating the procedure of operation in Application Example 3 of the method for replacement of nuclear reactor pressure vessel in this invention.

Figure 18 is a flow chart illustrating the procedure of operation in Application Example 4 of the method for replacement of nuclear reactor pressure vessel in this invention.

Figure 19 is a flow chart illustrating the procedure of operation in Application Example 5 of the method for replacement of nuclear reactor pressure vessel in this invention.

Figure 20 is a flow chart illustrating the procedure of operation in Application Example 6 of the method for replacement of nuclear reactor pressure vessel in this invention.

Brief explanation of symbols

- 1 Nuclear reactor building
- 2 Frame
- 3 Air lock (first air lock)
- 4 Air lock (third air lock)
- 5 Air lock (second air lock)
- 6 Flatcar
- 7 Crane
- 8 Accommodating equipment
- 9 Roof
- 10 Opening portion
- 11 Tower crane
- 12 Nuclear reactor pressure vessel
- 13 Running flatcar
- 14 Maintenance building
- 15 Operation pit
- 16 Hoisting-up chamber
- 17 Hoisting-out chamber
- 19 Operation chamber
- 20 Ceiling running crane
- 21 Fuel storing chamber
- 22 Fuel storing pool
- 23 Fuel storing pit
- 24 Ceiling crane
- 25 Heat shielding body
- 26 Nuclear reactor well
- 27 Pedestal
- 28 Operation pit
- 29 Water gate
- 30 Crawler crane
- 31 Air dome
- 32 Gantry structural body
- 33 Accommodating equipment
- 34, 35 Air lock
- 36 Gantry crane
- 37 Guide rail
- 38 Simple accommodating equipment
- 39 Simple lid

//insert figure 1//

Figure 1

- Key:
- S1 Shut-down of nuclear reactor
 - S2 Preparation of removal of nuclear reactor pressure vessel
 - S3 Embodiment of operation for forming opening on roof of nuclear reactor building
 - S4 Removal of nuclear reactor pressure vessel
 - S5 Removal of heat shielding body
 - S6 Installation of new pressure vessel
 - S7 Assembly of new heat shielding body
 - S8 Binding of various members to nuclear reactor pressure vessel
 - S9 Withdrawal of equipment for removal of nuclear reactor pressure vessel
 - S10 Reloading of fuel
 - S11 Restart of nuclear reactor

//insert figure 2//

Figure 2. Preparation of removal of nuclear reactor pressure vessel

- Key:
- S21 Removal of head portion of nuclear reactor accommodating container; removal of upper lid of nuclear reactor pressure vessel
 - S22 Removal of internal structural members
 - S23 Removal of fuel from nuclear reactor pressure vessel to fuel storing pool
 - S24 Transporting of fuel from pool to maintenance building for storage
 - S25 Mounting of internal structural members on nuclear reactor pressure vessel;

- S26 mounting of upper lid
Setting of equipment for removal of nuclear reactor pressure vessel above roof of nuclear reactor building

//insert figure 3//

Figure 3. Embodiment of the operation for forming opening on roof of nuclear reactor building

- Key:
- S31 Setup for temporary curing of upper surface of nuclear reactor well
 - S32 Connecting of roof of nuclear reactor building to equipment for removal of nuclear reactor pressure vessel in air tight state
 - S33 Installation of fixture for cutting operation on roof of nuclear reactor building
 - S34 Binding of equipment for removal of nuclear reactor pressure vessel to fixture of roof
 - S35 Cutting of a block of roof by a cutter using a laser beam or the like
 - S36 Transporting, disassembly and storage of cut block of roof to maintenance building
 - S37 Mounting of lid on opening portion of roof
 - S38 Setup for temporary curing of upper surface of nuclear reactor well

//insert figure 4//

Figure 4. Removal of nuclear reactor pressure vessel

- Key:
- S41 Binding of equipment for removal of nuclear reactor pressure vessel to nuclear reactor pressure vessel [sic]
 - S42 Cutting of connecting pipeline of nuclear reactor pressure vessel
 - S43 Withdrawal of blocking member between nuclear reactor pressure vessel and accommodating container
 - S44 Cutting of nuclear reactor pressure vessel from pedestal
 - S45 Hoisting of nuclear reactor pressure vessel from nuclear reactor building and carrying on running flatcar
 - S46 Transporting of nuclear reactor pressure vessel by running flatcar to maintenance building
 - S47 Disassembly, cleaning of pollution, dissection, cutting and storing of nuclear reactor pressure vessel in maintenance building

//insert figure 5//

Figure 5. Removal of heat shielding body

- Key:
- S51 Binding of equipment for removal of nuclear reactor pressure vessel to heat shielding body
 - S52 Cutting of heat shielding body from pedestal
 - S53 Hoisting of heat shielding body from nuclear reactor building and carrying it on running flatcar
 - S54 Transporting of heat shielding body to maintenance building by running flatcar
 - S55 Disassembly and storage of heat shielding body in maintenance building

//insert figure 6//

Figure 6. Installation of new pressure vessel

- Key:
- S61 Installation of new nuclear reactor pressure vessel by running flatcar
 - S62 Installation of new nuclear reactor pressure vessel by running flatcar with the aid of equipment for removal of nuclear reactor pressure vessel
 - S63 Installation of new nuclear reactor pressure vessel on pedestal
 - S64 Releasing of binding between equipment for removal of nuclear reactor pressure vessel and new nuclear reactor pressure vessel

//insert figure 7//

Figure 7. Binding of various members to nuclear reactor pressure vessel

- Key:
- S71 Connection of pipeline to nozzle of nuclear reactor pressure vessel
 - S72 Connection of nuclear reactor pressure vessel and accommodating container by sealing bellows
 - S73 Mounting of CRD on nuclear reactor pressure vessel
 - S74 Pressure resistance test

//insert figure 8//

Figure 8. Withdrawal of equipment for removal of nuclear reactor pressure vessel

- Key:
- S81 Closing of opening portion on roof of nuclear reactor building by lid
 - S82 Releasing of air tight state between roof of nuclear reactor building and equipment for removal of nuclear reactor pressure vessel
 - S83 Withdrawal of equipment for removal of nuclear reactor pressure vessel from above roof of nuclear reactor building

//insert figure 9//

Figure 9. Reloading of fuel

- Key:
- S91 Removal of upper lid nuclear reactor pressure vessel
 - S92 Removal of internal structural members
 - S93 Transporting of fuel from maintenance building to fuel storing pool
 - S94 Loading of fuel from fuel storing pool to core of nuclear reactor
 - S95 Assembly of internal structural members
 - S96 Mounting of upper lid of nuclear reactor pressure vessel
 - S97 Mounting of head portion of accommodating container

//insert figure 10//

Figure 10

//insert figure 11//

Figure 11

//insert figure 12//

Figure 12

//insert figure 13//

Figure 13

//insert figure 14//

Figure 14

//insert figure 15//

Figure 15

//insert figure 16//

Figure 16

- Key:
- P1 Shut-down of nuclear reactor
 - P2 Preparation of removal of nuclear reactor pressure vessel
 - P3 Embodiment of operation for forming opening on roof of nuclear reactor building
 - P4 Removal of nuclear reactor pressure vessel
 - P5 Removal of heat shielding body
 - P6 Installation of heat shielding body
 - P7 Installation of new pressure vessel
 - P8 Binding of various members to nuclear reactor pressure vessel
 - P9 Withdrawal of equipment for removal of nuclear reactor pressure vessel
 - P10 Reloading of fuel
 - P11 Restart of nuclear reactor

//insert figure 17//

Figure 17

- Key:
- P21 Shut-down of nuclear reactor
 - P22 Preparation of removal of nuclear reactor pressure vessel
 - P23 Embodiment of operation for forming opening on roof of nuclear reactor building
 - P24 Removal of nuclear reactor pressure vessel
 - P25 Removal of heat shielding body
 - P26 Removal of control rod driving device's handler
 - P27 Remodeling of pedestal
 - P28 Installation of new internal pump/control rod driving device's handler
 - P29 Installation of new pressure vessel
 - P30 Binding of various members to nuclear reactor pressure vessel
 - P31 Withdrawal of equipment for removal of nuclear reactor pressure vessel
 - P32 Reloading of fuel
 - P33 Restart of nuclear reactor

//insert figure 18//

Figure 18

- Key: P41 Shut-down of nuclear reactor
P42 Preparation of removal of nuclear reactor pressure vessel
P43 Embodiment of operation for forming opening on roof of nuclear reactor building
P44 Removal of nuclear reactor pressure vessel
P45 Installation of new pressure vessel
P46 Binding of various members to nuclear reactor pressure vessel
P47 Withdrawal of equipment for removal of nuclear reactor pressure vessel
P48 Reloading of fuel
P49 Restart of nuclear reactor

//insert figure 19//

Figure 19

- Key: P51 Shut-down of nuclear reactor
P52 Preparation of removal of nuclear reactor pressure vessel
P53 Embodiment of operation for forming opening on roof of nuclear reactor building
P54 Removal of nuclear reactor pressure vessel
P55 Removal of internal pump/control rod driving device's handler
P56 Installation of new internal pump/control rod driving device's handler
P57 Installation of new pressure vessel
P58 Binding of various members to nuclear reactor pressure vessel
P59 Withdrawal of equipment for removal of nuclear reactor pressure vessel
P60 Reloading of fuel
P61 Restart of nuclear reactor

//insert figure 20//

Figure 20

- Key:
- P71 Shut-down of nuclear reactor
 - P72 Preparation of removal of nuclear reactor pressure vessel
 - P73 Removal of nuclear reactor pressure vessel
 - P74 Installation of new pressure vessel
 - P75 Binding of various members to nuclear reactor pressure vessel
 - P76 Withdrawal of equipment for removal of nuclear reactor pressure vessel
 - P77 Reloading of fuel
 - P78 Restart of nuclear reactor

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(57) 【要約】

(57)[SUMMARY]

【目的】

大気中に放射線を放出させるこ
とのない原子炉圧力容器の搬出
方法を提供する。

[OBJECT]

The method of carrying out a reactor pressure
vessel which does not make a radiation
discharge in air is provided.

【構成】

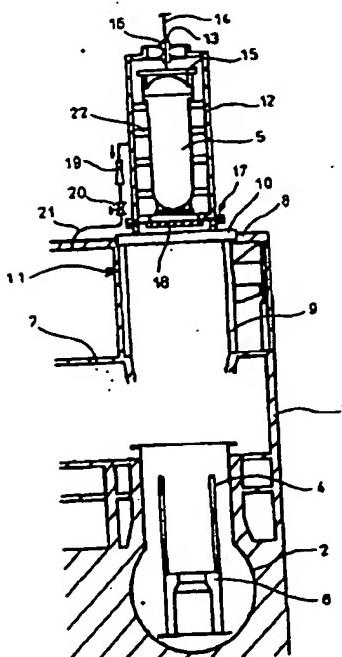
原子炉圧力容器5を、原子炉建
屋1の屋根8を撤去した部分の
上方にありかつ内部の空気が排
気されているエアロック12内

[SUMMARY OF THE INVENTION]

After storing a reactor pressure vessel 5 in the
air lock 12 with which internal air is exhausted
with the upper part of the part which removed
the roof 8 of a nuclear reactor building 1, the

に格納したうえ仕切り用ハッチ 18 を閉鎖し、原子炉圧力容器 5 を内部が負圧状態のエアロック 12 ごと原子炉建屋 1 を外に搬出する。

hatch for partitions 18 is closed. A nuclear reactor building 1 is taken out a reactor pressure vessel 5 outside every air lock 12 whose inside is in negative-pressure condition.



【特許請求の範囲】

[CLAIMS]

【請求項 1】

原子炉圧力容器が格納された原子炉格納容器の直上部にある原子炉建屋の屋根を撤去した後、原子炉建屋の屋根の撤去部に載置台をセットし、該載置台上に、密閉容器状で下部に開閉可能な仕切り用ハッチを備えたエアロックを載置、固定すると共に前記エアロックに接続されたエジェクタを作動させてエアロック

[CLAIM 1]

After removing the roof of the nuclear reactor building in the right upper part of the nuclear reactor containment by which the reactor pressure vessel was stored, a mount stand is set to the removal part of the roof of a nuclear reactor building.

While performing the air lock which provided the lower part with the open able hatch for partitions by the shape of a sealing container, a mount and fixation on this mount stand make the ejector connected to the above-mentioned air lock, and air in an air lock is exhausted in a

内の空気を原子炉建屋内に排気し、前記エアロックの天井部に取付けたシール部材を通して前記エアロック内に垂下されかつ下端に天秤を備えた吊り上げワイヤを下降させることにより、前記天秤を仕切り用ハッチが開いた状態のエアロックから原子炉建屋内の蓋が撤去された原子炉格納容器の上端まで下降させ、次いで前記天秤を原子炉圧力容器に連結し、原子炉圧力容器を該原子炉圧力容器が支持されているペデスタルから切り離したうえ吊り上げワイヤを上昇させることにより原子炉圧力容器を吊り上げて前記エアロック内に格納し、エアロック内に格納された原子炉圧力容器を固定治具によりエアロック内に支持させた後、前記仕切り用ハッチを閉鎖し、続いてエアロック内の排気を行っている前記エジェクタの排気側にある排気弁を閉止したうえ前記エアロックを載置台から切り離し、原子炉格納容器を格納したエアロックを原子炉建屋外へ搬送することを特徴とする原子炉圧力容器の搬出方法。

【発明の詳細な説明】

【0001】

【産業上の利用分野】

本発明は、既に発電を開始したプラントの原子炉圧力容器を原子炉建屋外に搬出する原子炉圧力容器の搬出方法に関する、

nuclear reactor building. The lifting wire which passes through an attached sealing member among the ceiling part of an above-mentioned air lock, and is suspended in an above-mentioned air lock, and provided the lower end with the balance is made to descend. Thereby, an above-mentioned balance is made to descend from the air lock of the condition that the hatch for partitions opened to the upper end of the nuclear reactor containment by which the lid in a nuclear reactor building was removed. Subsequently an above-mentioned balance is connected with a reactor pressure vessel. After detaching a reactor pressure vessel from the pedestal where this reactor pressure vessel is supported by raising a lifting wire, a reactor pressure vessel is lifted and it stores in an above-mentioned air lock.

After making the reactor pressure vessel stored in the air lock support in an air lock by the fixing jig, the hatch for above-mentioning partitions is closed.

Subsequently after closing the exhaust valve in the exhaust-gas side of the above-mentioned ejector which is performing the exhaust gas in an air lock, an above-mentioned air lock is detached from a mount stand. The air lock which stored the nuclear reactor containment is conveyed out of a nuclear reactor building.

Method of carrying out a reactor pressure vessel characterized by the above-mentioned.

[DETAILED DESCRIPTION OF INVENTION]

[0001]

[INDUSTRIAL APPLICATION]

This invention relates to the method of carrying out a reactor pressure vessel which takes out the reactor pressure vessel of the plant which already started the electricity generation, out of a nuclear reactor building.

[0002]

[0002]

【従来の技術】

原子力発電所の原子炉建屋内に収容した原子炉圧力容器は略30年程度の寿命を持っており、寿命に達するとプラント全体を廃棄して新たに建設し直す必要がある。しかしながら新たなプラント設置場所の確保が困難になることが予想され、あるいは、未だ使用できる他の機器も同様に廃棄するとなると無駄が発生するなどの理由により、寿命に達した原子炉圧力容器のみを交換する技術が注目を集めている。

[PRIOR ART]

The reactor pressure vessel accommodated in the nuclear reactor building of a nuclear power station has the durability for about 30 years.

If durability is reached, an entire plant is discarded and it needs to rebuild newly. However, it is expected that ensuring of a new plant installation place becomes difficult.

Or, if the other apparatus which can still be used is discarded similarly, waste will be generated. The technique that only the reactor pressure vessel reached to the durability is exchanged for the reason of above etc. has attracted attention.

[0003]

[0003]

【発明が解決しようとする課題】

しかしながら、寿命に達したりその他の理由により、既に発電を開始しているプラントの原子炉圧力容器を原子炉建屋外に搬出しようとすると、大気中に放射線を放出する危険性があった。

[PROBLEM ADDRESSED]

However, by the reasons reaching to the durability and the other, when it was going to take out the reactor pressure vessel of the plant which has already started the electricity generation, out of the nuclear reactor building, there was a risk of discharging a radiation in air.

[0004]

本発明はこのような背景に基いてなされたものであり、大気中に放射線を放出させることのない原子炉圧力容器の搬出方法を提供することを目的とする。

[0004]

This invention is made based on such a background.

It aims at providing the method of carrying out a reactor pressure vessel which does not make a radiation discharge in air.

[0005]

[0005]

【課題を解決するための手段】

この目的を達成するために、本発明では、原子炉圧力容器が格納された原子炉格納容器の直上部にある原子炉建屋の屋根を撤去した後、原子炉建屋の屋根の撤去部に載置台をセットし、該載置台上に、密閉容器状で下部に開閉可能な仕切り用ハッチを備えたエアロックを設置、固定すると共に前記エアロックに接続されたエジェクタを作動させてエアロック内の空気を原子炉建屋内に排気し、前記エアロックの天井部に取付けたシール部材を通して前記エアロック内に垂下されかつ下端に天秤を備えた吊り上げワイヤを下降させることにより、前記天秤を仕切り用ハッチが開いた状態のエアロックから原子炉建屋内の蓋が撤去された原子炉格納容器の上端まで下降させる、次いで前記天秤を原子炉圧力容器に連結し、原子炉圧力容器を該原子炉圧力容器が支持されているペデスタルから切り離したうえ吊り上げワイヤを上昇させることにより原子炉圧力容器を吊り上げて前記エアロック内に格納し、エアロック内に格納された原子炉圧力容器を固定治具によりエアロック内に支持させた後、前記仕切り用ハッチを閉鎖し、続いてエアロック内の排気を行っている前記エジェクタの排気側にある排気弁を閉止したうえ前記エアロックを載置台から切り離し、原子炉格納容器を格納したエアロックを原子炉建屋外へ搬送するようにしている。

[SOLUTION OF THE INVENTION]

In order to attain this objective, with this invention, after removing the roof of the nuclear reactor building in the right upper part of the nuclear reactor containment by which the reactor pressure vessel was stored, a mount stand is set to the removal part of the roof of a nuclear reactor building.

While performing the air lock provided with the hatch for partitions open able in the lower part by the shape of a sealing container on this mount stand a mount and fixation

The ejector connected to the above-mentioned air lock is made to operate, and air in an air lock is exhausted in a nuclear reactor building. The lifting wire which passes through an attached sealing member among the ceiling part of an above-mentioned air lock, and is suspended in an above-mentioned air lock, and provided the lower end with the balance is made to descend. Thereby, an above-mentioned balance is made to descend from the air lock of the condition that the hatch for partitions opened to the upper end of the nuclear reactor containment by which the lid in a nuclear reactor building was removed.

Subsequently an above-mentioned balance is connected with a reactor pressure vessel. After detaching a reactor pressure vessel from the pedestal where this reactor pressure vessel is supported by raising a lifting wire, a reactor pressure vessel is lifted and it stores in an above-mentioned air lock. After making the reactor pressure vessel stored in the air lock support in an air lock by the fixing jig, the hatch for above-mentioning partitions is closed. Subsequently after closing the exhaust valve in the exhaust-gas side of the above-mentioned ejector. It is performing the exhaust gas in an air lock. An above-mentioned air lock is detached from a mount stand. It is made to convey the air lock which ... stored the nuclear reactor containment, out of a nuclear reactor building.

[0006]

[0006]

【作用】

原子炉圧力容器を、原子炉建屋の屋根を撤去した部分の上方にありかつ内部の空気が排気されているエアロック内に格納したうえ仕切り用ハッチを閉鎖し、原子炉圧力容器を内部が負圧状態のエアロックごと原子炉建屋外に搬送するため、搬送時にエアロックから放射線が漏洩することがない。

[EFFECT]

After storing a reactor pressure vessel in the air lock with which internal air is exhausted with the upper part of the part. It removed the roof of a nuclear reactor building. The hatch for partitions is closed and a reactor pressure vessel is conveyed out of a nuclear reactor building every air lock whose inside is in negative pressure condition. Therefore, a radiation does not leak from an air lock at the time of conveying.

[0007]

[0007]

【実施例】

以下、本発明の一実施例を図面に基づいて説明する。

[Example]

Hereafter, one example of this invention is explained based on a drawing.

[0008]

図1ないし図5は原子炉圧力容器の搬出方法の手順を示すための各状態の概略図である。

[0008]

Fig. 1 or 5 is schematic of each condition for the procedure of The method of carrying out a reactor pressure vessel being shown.

[0009]

図1は第1ステップとしての仮設架台設置状態の概略図であり、1は原子炉建屋、2はその内部の原子炉格納容器であり、原子炉格納容器2には蓋3を設けている。4は原子炉格納容器2内に設けた遮蔽壁、5は遮蔽壁4の内部に収容し、底部をペデスタル6に固定した原子炉圧力容器、7は原子炉格納容器2の上方に設けた、原子炉建屋1の作業床、8は原子炉建屋1の屋根である。

[0009]

Fig. 1 is schematic of the temporary frame installation condition as the 1st step.

1 is a nuclear reactor building. 2 is the nuclear reactor containment of that inside.

The lid 3 is provided to the nuclear reactor containment 2.

4 is the shield wall provided in the nuclear reactor containment 2. 5 is the reactor pressure vessel which accommodated in the inside of the shield wall 4, and fixed the bottom part to the pedestal 6. 7 is the operation floor of a nuclear reactor building 1 which the nuclear reactor containment 2 provided upwardly. 8 is the roof of a nuclear reactor building 1.

[0010]

[0010]

このような内部構造の原子炉建屋1に対してまず、原子炉格納容器2の直上部にある屋根8の一部を撤去し、原子炉格納容器2の上方の作業床7と屋根8を撤去した箇所との間に、脚部9の下端が作業床7上に起立し、かつ、上端に屋根8と水平な載置台10が固定された仮設架台11を設置する。

[0011]

図2は仮設架台上にエアロックを設置した状態の概略図であり、エアロック12はクレーン等によって仮設架台11の載置台10上に載置される。

[0012]

エアロック12は筒型をしており、上面のワイヤ挿入口13から内部に垂下しかつクレーン巻上機により巻取り、繰出し自在な吊り上げワイヤ14の下端には、圧力容器吊り上げ用の天秤15を取り付けている。またワイヤ挿入口13は可撓性のシール部材16でシールしており、このシール部材16は吊り上げワイヤ14を上下させるごとに図において模式的に示すように上方と下方に反転し得るようになっている。17はエアロック12下端部と仮設架台11上面の載置台10を接続するための取り合いフランジ、18は取り合いフランジ17の部分に設けられ、かつ、エアロック12を仕切るためのスライド可能な仕切り用ハッチ、19はエアロック12内を常時負圧にするため該エアロック12に接続された

As opposed to the nuclear reactor building 1 of such internal structure, first, a part of roof 8 in the right upper part of nuclear reactor containment 2 is removed.

Between the locations which removed the upward operation floor 7 and the upward roof 8 of a nuclear reactor containment 2, the temporary frame 11 with which the lower end of a leg 9 rises on the operation floor 7, and the mount stand 10 horizontal on a roof 8 was fixed to the upper end is installed.

[0011]

Fig. 2 is schematic of the condition of having installed the air lock on the temporary frame.

The air lock 12 is mounted on the mount stand 10 of the temporary frame 11 with a crane etc.

[0012]

The air lock 12 is performing the tube type. In the lower end of the lifting wire 14 with a winding and a delivery free by the crane winding machine which suspends inside from the wire insertion opening 13 on top, the balance 15 for pressure-vessel lifting is attached.

Moreover the wire insertion opening 13 is sealed by the flexible sealing member 16.

This sealing member 16 can be reversed downwardly with it being upward so that it may be shown typically in the figure whenever it makes the lifting wire 14 go up and down.

17 is a tie-in flange for connecting the mount stand 10 of air lock 12 bottom end and temporary frame 11 upper face. 18 is a hatch for partitions which can be slide for providing to the part of the tie-in flange 17, and dividing the air lock 12. 19 is the ejector connected to this air lock 12. It is in order to make the inside of the air lock 12 into a negative pressure for always.

Air in the air lock 12 is exhausted in a nuclear reactor building 1 via an exhaust valve 20 and the hose 21.



エジェクタであり、エアロック 12 内の空気を排気弁 20、ホース 21 を介して原子炉建屋 1 内に排気するようになっている。

【0013】

このよう付帯ユニットを有するエアロック 12 を載置台 10 上に載置したうえ取合いフランジ 17 の部分でボルト締結し、仕切り用ハッチ 18 を閉止したままで図示していない空気源から圧縮空気をエジェクタ 19 へ送給することにより、エアロック 12 内部の空気をホース 21 を介し原子炉建屋 1 内に排気する。エアロック 12 内の空気を排気する原子炉建屋 1 内の空間としては、原子炉格納容器 2 が収納された空間とは異なる空間とするのが望ましい。

【0014】

この状態から次に、図 3 に示すように原子炉格納容器 2 の蓋 3 を原子炉建屋 1 内に設置したマニピュレータにより取り外す。

【0015】

そして次に、図 4 に示すように仕切り用ハッチ 18 を開け、かつ、吊り上げワイヤ 14 を下げて天秤 15 を原子炉圧力容器 5 の鏡蓋部分に近接するまで降下させる。この状態で、天秤 15 を鏡蓋部分に連絡し、さらに、原子炉圧力容器 5 をペデスタル 6 より切り離す。

【0016】

次に、図 5 に示すようにクレー

[0013]

After mounting the air lock 12 which has such an incidental unit on the mount stand 10, the bolt fastening is performed in the part of the scramble flange 17.

Compressed air is supplied from the air supply not illustrated, closed the hatch for partitions 18 to an ejector 19. This exhausts air of air lock 12 inside in a nuclear reactor building 1 via a hose 21.

As for the space which accommodated the nuclear reactor containment 2, as space in the nuclear reactor building 1 which exhausts air in the air lock 12, considering as different space is preferable.

[0014]

Next it removes with the manipulator which installed the lid 3 of nuclear reactor containment 2 in the nuclear reactor building 1 as shown in Fig. 3 from this condition.

[0015]

And next, as shown in a Figure 4, the hatch for partitions 18 is opened. And, it is made to descend until it lowers the lifting wire 14 and it adjoins a balance 15 to the mirror lid part of a reactor pressure vessel 5.

In this condition, a balance 15 is communicated to a mirror lid part.

Furthermore, a reactor pressure vessel 5 is detached from a pedestal 6.

[0016]

Next, by lifting with the crane winding machine

ン巻上機により吊り上げワイヤ 14 を巻取ることで、天秤 15 を介して原子炉圧力容器 5 を吊り上げ、原子炉建屋 1 から撤去してエアロック 12 内に収納する。その後、固定治具 22 で原子炉圧力容器 5 をエアロック 12 内に固定して仕切り用ハッチ 18 を閉鎖し、取り合いフランジ 17 部分のボルトを取り外し、さらに排気弁 20 を閉とす。

【0017】

この状態で吊り上げワイヤ 14 を巻取ることにより、原子炉圧力容器 5 をエアロック 12 と一緒に吊り上げ搬出することができる。この際、エアロック 12 内は負圧になっているため、内部から放射線が漏洩する虞れはない。

【0018】

【発明の効果】

以上述べたように、本発明によれば、原子炉圧力容器を内部が負圧状態のエアロック中に格納し、搬送するようにしたので、原子炉圧力容器の原子炉建屋外へ搬出の際に放射線の漏れを確実に防止することができる。

【図面の簡単な説明】

【図 1】

本発明の実施例に係る原子炉圧力容器の搬出方法の手順を示す概略図で、原子炉建屋の屋根を

and rolling round a wire 14, as shown in Fig. 5, a reactor pressure vessel 5 is lifted via a balance 15. It removes from a nuclear reactor building 1, and it accommodates in the air lock 12.

After that, a reactor pressure vessel 5 is fixed in the air lock 12 by the fixing jig 22, the hatch for partitions 18 is closed, and the bolt of tie-in flange 17 part is removed.

Furthermore an exhaust valve 20 is closed.

[0017]

By lifting in this condition and rolling round a wire 14, a reactor pressure vessel 5 can be integrally lifted with the air lock 12, and can be taken out.

In this case, there is no possibility that a radiation may leak it from an inside since the inside of the air lock 12 forms the negative pressure.

[0018]

[EFFECT OF THE INVENTION]

As it described above. If according to this invention, a reactor pressure vessel is stored during the air lock whose inside is in negative-pressure condition, it was made to convey it. Therefore, out of the nuclear reactor building of a reactor pressure vessel, in the case it is sending out, the omission of a radiation can be prevented reliably.

[BRIEF EXPLANATION OF DRAWINGS]

[FIGURE 1]

It is the schematic showing the procedure of the method of carrying out a reactor pressure vessel based on the example of this invention. It is the vertical front view showing the condition

撤去した箇所に載置台をセットした状態を示す縦断正面図である。

[図 2]

本発明の実施例に係る原子炉圧力容器の搬出方法の手順を示す概略図で、載置台上にエアロックを載置した状態を示す縦断正面図である。

[図 3]

本発明の実施例に係る原子炉圧力容器の搬出方法の手順を示す概略図で、原子炉格納容器の蓋を外した状態を示す縦断正面図である。

[図 4]

本発明の実施例に係る原子炉圧力容器の搬出方法の手順を示す概略図で、原子炉圧力容器を天秤に接続した状態を示す縦断正面図である。

[図 5]

本発明の実施例に係る原子炉圧力容器の搬出方法の手順を示す概略図で、原子炉圧力容器をエアロックに格納した状態を示す縦断正面図である。

【符号の説明】

- 1 原子炉建屋
- 2 原子炉格納容器
- 3 蓋
- 5 原子炉圧力容器
- 6 ペデスタル
- 8 屋根
- 10 載置台
- 12 エアロック

of having set the mount stand to the location which removed the roof of a nuclear reactor building.

[FIGURE 2]

It is the schematic showing the procedure of the method of carrying out a reactor pressure vessel based on the example of this invention. It is the vertical front view showing the condition of having mounted the air lock on the mount stand.

[FIGURE 3]

It is the schematic showing the procedure of the method of carrying out a reactor pressure vessel based on the example of this invention. It is the vertical front view showing the condition of removed the lid of nuclear reactor containment.

[FIGURE 4]

It is the schematic showing the procedure of the method of carrying out a reactor pressure vessel based on the example of this invention. It is the vertical front view showing the condition of having connected the reactor pressure vessel to the balance.

[FIGURE 5]

It is the schematic showing the procedure of the method of carrying out a reactor pressure vessel based on the example of this invention. It is the vertical front view showing the condition of having stored the reactor pressure vessel in the air lock.

[EXPLANATION OF DRAWING]

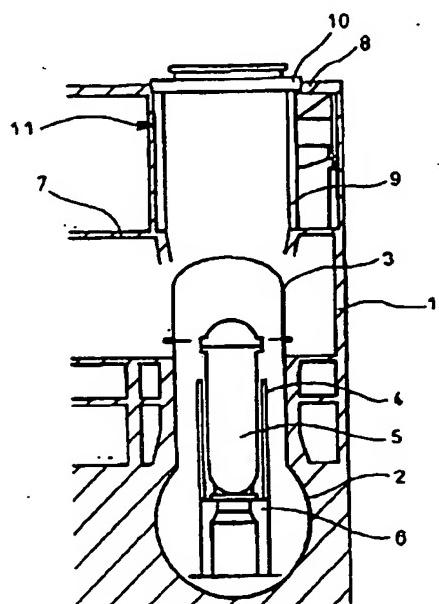
- 1 Nuclear reactor building
- 2 Nuclear reactor containment
- 3 Lid
- 5 Reactor pressure vessel
- 6 Pedestal
- 8 Roof
- 10 Mount stand
- 12 Air lock
- 14 Lifting wire
- 15 Balance

1 4 吊り上げワイヤ
1 5 天秤
1 6 シール部材
1 8 仕切り用ハッチ
1 9 エジェクタ
2 0 排気弁

16 Sealing member
18 Hatch for partitions
19 Ejector
20 Exhaust valve

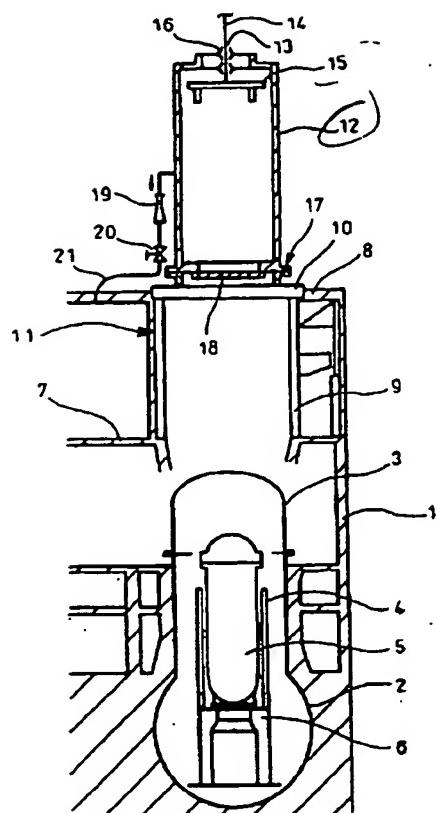
【図1】

[FIGURE 1]



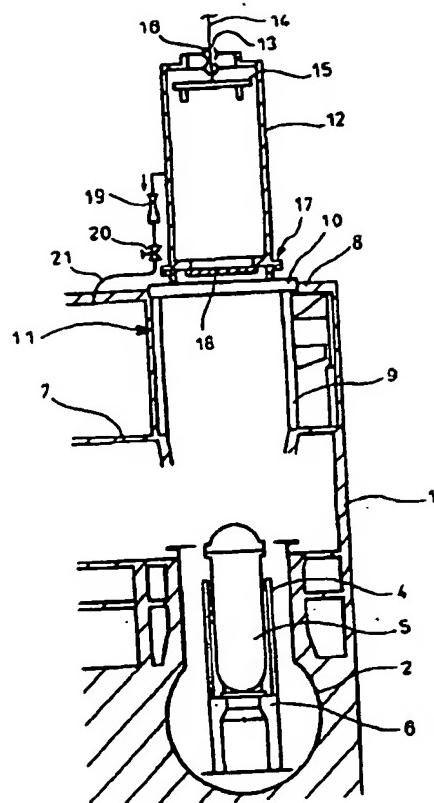
【図2】

[FIGURE 2]



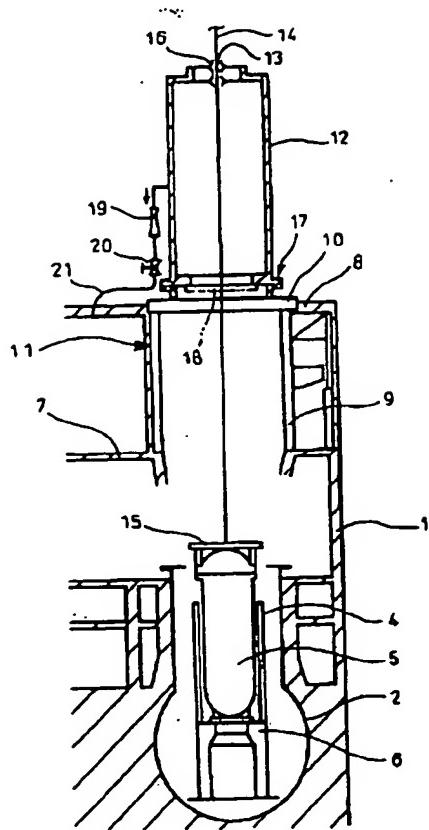
【図3】

[FIGURE 3]



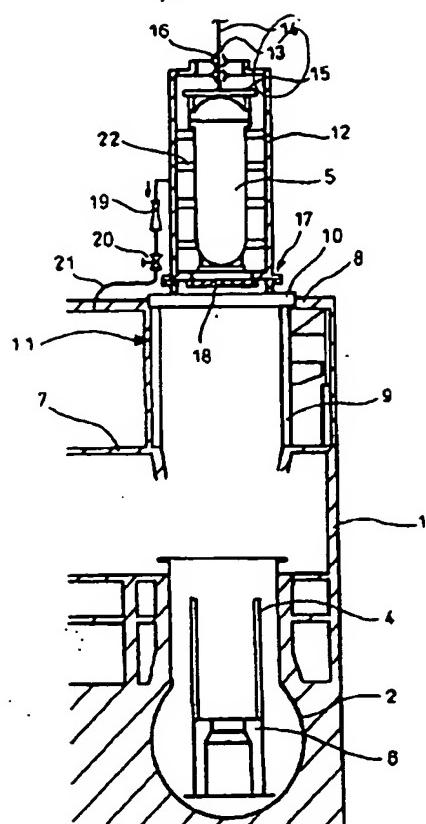
[図 4]

[FIGURE 4]



【図5】

[FIGURE 5]



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L12: Entry 1 of 2

File: JPAB

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PUB-N0: JP406230188A

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APPL-NO: JP05040426

APPL-DATE: February 4, 1993

INT-CL (IPC): G21F 9/30; G21F 9/30

ABSTRACT:

PURPOSE: To provide a carryout method for reactor pressure vessel without emitting radiation in the environment.

CONSTITUTION: A reactor pressure vessel 5 is contained in an airlock 12 which is above the removed roof 8 of a reactor building 1 and of which inside air is discharged, a partition hatch 18 is closed and then the reactor pressure vessel 5 is carried out of the reactor building 1 together with the airlock 12 with negative inner pressure.

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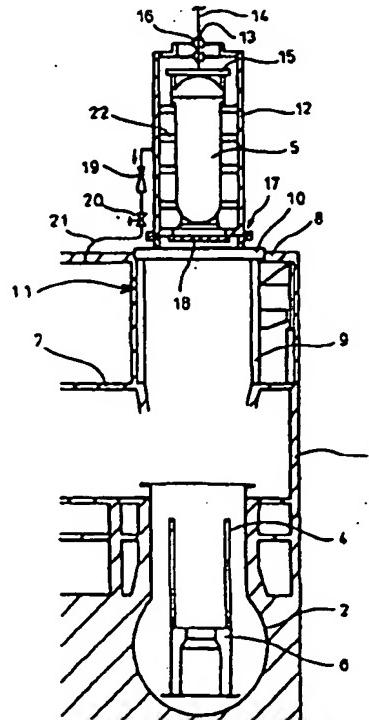
S.T.I.C. Translations Branch

(54)【発明の名称】原子炉圧力容器の搬出方法

(57)【要約】

【目的】大気中に放射線を放出させることのない原子炉圧力容器の搬出方法を提供する。

【構成】原子炉圧力容器5を、原子炉建屋1の屋根8を撤去した部分の上方にありかつ内部の空気が排気されているエアロック12内に格納したうえ仕切り用ハッチ18を閉鎖し、原子炉圧力容器5を内部が負圧状態のエアロック12ごと原子炉建屋1を外に搬出する。



【特許請求の範囲】

【請求項1】 原子炉圧力容器が格納された原子炉格納容器の直上部にある原子炉建屋の屋根を撤去した後、原子炉建屋の屋根の撤去部に載置台をセットし、該載置台上に、密閉容器状で下部に開閉可能な仕切り用ハッチを備えたエアロックを載置、固定すると共に前記エアロックに接続されたエジェクタを作動させてエアロック内の空気を原子炉建屋内に排気し、前記エアロックの天井部に取付けたシール部材を通して前記エアロック内に垂下されかつ下端に天秤を備えた吊り上げワイヤを下降させることにより、前記天秤を仕切り用ハッチが開いた状態のエアロックから原子炉建屋内の蓋が撤去された原子炉格納容器の上端まで下降させ、次いで前記天秤を原子炉圧力容器に連結し、原子炉圧力容器を該原子炉圧力容器が支持されているペデスタルから切り離したうえ吊り上げワイヤを上昇させることにより原子炉圧力容器を吊り上げて前記エアロック内に格納し、エアロック内に格納された原子炉圧力容器を固定治具によりエアロック内に支持させた後、前記仕切り用ハッチを閉鎖し、統いてエアロック内の排気を行っている前記エジェクタの排気側にある排気弁を閉止したうえ前記エアロックを載置台から切り離し、原子炉格納容器を格納したエアロックを原子炉建屋外へ搬送することを特徴とする原子炉圧力容器の搬出方法。

【発明の詳細な説明】

【0001】

【産業上の利用分野】 本発明は、既に発電を開始したプラントの原子炉圧力容器を原子炉建屋外に搬出する原子炉圧力容器の搬出方法に関する。

【0002】

【従来の技術】 原子力発電所の原子炉建屋内に収容した原子炉圧力容器は略30年程度の寿命を持っており、寿命に達するとプラント全体を廃棄して新たに建設し直す必要がある。しかしながら新たなプラント設置場所の確保が困難になることが予想され、あるいは、未だ使用できる他の機器も同様に廃棄するとなると無駄が発生するなどの理由により、寿命に達した原子炉圧力容器のみを交換する技術が注目を集めている。

【0003】

【発明が解決しようとする課題】 しかしながら、寿命に達したりその他の理由により、既に発電を開始しているプラントの原子炉圧力容器を原子炉建屋外に搬出しようとすると、大気中に放射線を放出する危険性があった。

【0004】 本発明はこのような背景に基づいてなされたものであり、大気中に放射線を放出させることのない原子炉圧力容器の搬出方法を提供することを目的とする。

【0005】

【課題を解決するための手段】 この目的を達成するために、本発明では、原子炉圧力容器が格納された原子炉格

納容器の直上部にある原子炉建屋の屋根を撤去した後、原子炉建屋の屋根の撤去部に載置台をセットし、該載置台上に、密閉容器状で下部に開閉可能な仕切り用ハッチを備えたエアロックを載置、固定すると共に前記エアロックに接続されたエジェクタを作動させてエアロック内の空気を原子炉建屋内に排気し、前記エアロックの天井部に取付けたシール部材を通して前記エアロック内に垂下されかつ下端に天秤を備えた吊り上げワイヤを下降させることにより、前記天秤を仕切り用ハッチが開いた状態のエアロックから原子炉建屋内の蓋が撤去された原子炉格納容器の上端まで下降させる、次いで前記天秤を原子炉圧力容器に連結し、原子炉圧力容器を該原子炉圧力容器が支持されているペデスタルから切り離したうえ吊り上げワイヤを上昇させることにより原子炉圧力容器を吊り上げて前記エアロック内に格納し、エアロック内に格納された原子炉圧力容器を固定治具によりエアロック内に支持させた後、前記仕切り用ハッチを閉鎖し、統いてエアロック内の排気を行っている前記エジェクタの排気側にある排気弁を閉止したうえ前記エアロックを載置台から切り離し、原子炉格納容器を格納したエアロックを原子炉建屋外へ搬送するようにしている。

【0006】

【作用】 原子炉圧力容器を、原子炉建屋の屋根を撤去した部分の上方にありかつ内部の空気が排気されているエアロック内に格納したうえ仕切り用ハッチを閉鎖し、原子炉圧力容器を内部が負圧状態のエアロックごと原子炉建屋外へ搬送するため、搬送時にエアロックから放射線が漏洩することがない。

【0007】

【実施例】 以下、本発明の一実施例を図面に基づいて説明する。

【0008】 図1ないし図5は原子炉圧力容器の搬出方法の手順を示すための各状態の概略図である。

【0009】 図1は第1ステップとしての仮設架台設置状態の概略図であり、1は原子炉建屋、2はその内部の原子炉格納容器であり、原子炉格納容器2には蓋3を設けている。4は原子炉格納容器2内に設けた遮蔽壁、5は遮蔽壁4の内部に収容し、底部をペデスタル6に固定した原子炉圧力容器、7は原子炉格納容器2の上方に設けた、原子炉建屋1の作業床、8は原子炉建屋1の屋根である。

【0010】 このような内部構造の原子炉建屋1に対してまず、原子炉格納容器2の直上部にある屋根8の一部を撤去し、原子炉格納容器2の上方の作業床7と屋根8を撤去した箇所との間に、脚部9の下端が作業床7上に起立し、かつ、上端に屋根8と水平な載置台10が固定された仮設架台11を設置する。

【0011】 図2は仮設架台上にエアロックを設置した状態の概略図であり、エアロック12はクレーン等によって仮設架台11の載置台10上に設置される。

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〔0012〕エアロック12は筒型をしており、上面のワイヤ挿入口13から内部に垂下しかつクレーン巻上機により巻取り、繰出し自在な吊り上げワイヤ14の下端には、圧力容器吊り上げ用の天秤15を取り付けている。またワイヤ挿入口13は可撓性のシール部材16でシールしており、このシール部材16は吊り上げワイヤ14を上下させることに因において模式的に示すように上方と下方に反転し得るようになっている。17はエアロック12下端部と仮設架台11上面の載置台10を接続するための取り合いフランジ、18は取り合いフランジ17の部分に設けられ、かつ、エアロック12を仕切るためのスライド可能な仕切り用ハッチ、19はエアロック12内を常時負圧にするため該エアロック12に接続されたエジェクタであり、エアロック12内の空気を排気弁20、ホース21を介して原子炉建屋1内に排気するようになっている。

〔0013〕このような付帯ユニットを有するエアロック12を載置台10上に載置したうえ取合いフランジ17の部分でボルト締結し、仕切り用ハッチ18を閉止したままで図示していない空気源から圧縮空気をエジェクタ19へ送給することにより、エアロック12内部の空気をホース21を介し原子炉建屋1内に排気する。エアロック12内の空気を排気する原子炉建屋1内の空間としては、原子炉格納容器2が収納された空間とは異なる空間とするのが望ましい。

〔0014〕この状態から次に、図3に示すように原子炉格納容器2の蓋3を原子炉建屋1内に設置したマニピュレータにより取り外す。

〔0015〕そして次に、図4に示すように仕切り用ハッチ18を開け、かつ、吊り上げワイヤ14を下げて天秤15を原子炉圧力容器5の鏡蓋部分に近接するまで降下させる。この状態で、天秤15を鏡蓋部分に連絡し、さらに、原子炉圧力容器5をペデスタル6より切り離す。

〔0016〕次に、図5に示すようにクレーン巻上機により吊り上げワイヤ14を巻取ることで、天秤15を介して原子炉圧力容器5を吊り上げ、原子炉建屋1から撤去してエアロック12内に収納する。その後、固定治具22で原子炉圧力容器5をエアロック12内に固定して仕切り用ハッチ18を閉鎖し、取り合いフランジ17部分のボルトを取り外し、さらに排気弁20を閉とする。

〔0017〕この状態で吊り上げワイヤ14を巻取るこ

とにより、原子炉圧力容器5をエアロック12と一緒に吊り上げ搬出することができる。この際、エアロック12内は負圧になっているため、内部から放射線が漏洩する虞れはない。

〔0018〕

【発明の効果】以上述べたように、本発明によれば、原子炉圧力容器を内部が負圧状態のエアロック中に格納し、搬送するようにしたので、原子炉圧力容器の原子炉建屋外へ搬出の際に放射線の漏れを確実に防止することができます。

【図面の簡単な説明】

【図1】本発明の実施例に係る原子炉圧力容器の搬出方法の手順を示す概略図で、原子炉建屋の屋根を撤去した箇所に載置台をセットした状態を示す縦断正面図である。

【図2】本発明の実施例に係る原子炉圧力容器の搬出方法の手順を示す概略図で、載置台上にエアロックを載置した状態を示す縦断正面図である。

【図3】本発明の実施例に係る原子炉圧力容器の搬出方法の手順を示す概略図で、原子炉格納容器の蓋を外した状態を示す縦断正面図である。

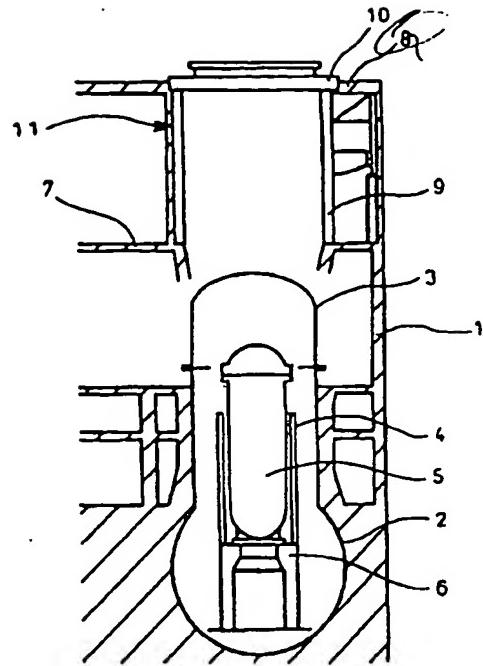
【図4】本発明の実施例に係る原子炉圧力容器の搬出方法の手順を示す概略図で、原子炉圧力容器を天秤に接続した状態を示す縦断正面図である。

【図5】本発明の実施例に係る原子炉圧力容器の搬出方法の手順を示す概略図で、原子炉圧力容器をエアロックに格納した状態を示す縦断正面図である。

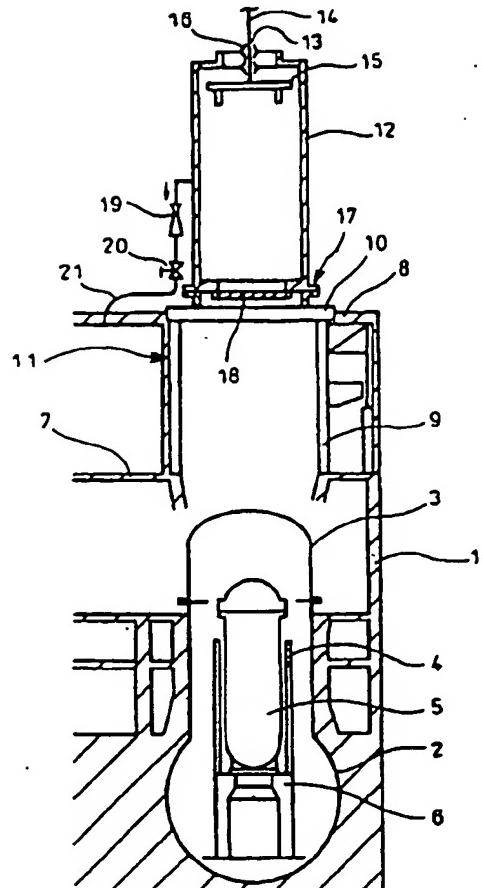
【符号の説明】

- 1 原子炉建屋
- 2 原子炉格納容器
- 3 蓋
- 5 原子炉圧力容器
- 6 ペデスタル
- 8 屋根
- 10 載置台
- 12 エアロック
- 14 吊り上げワイヤ
- 15 天秤
- 16 シール部材
- 18 仕切り用ハッチ
- 19 エジェクタ
- 20 排気弁

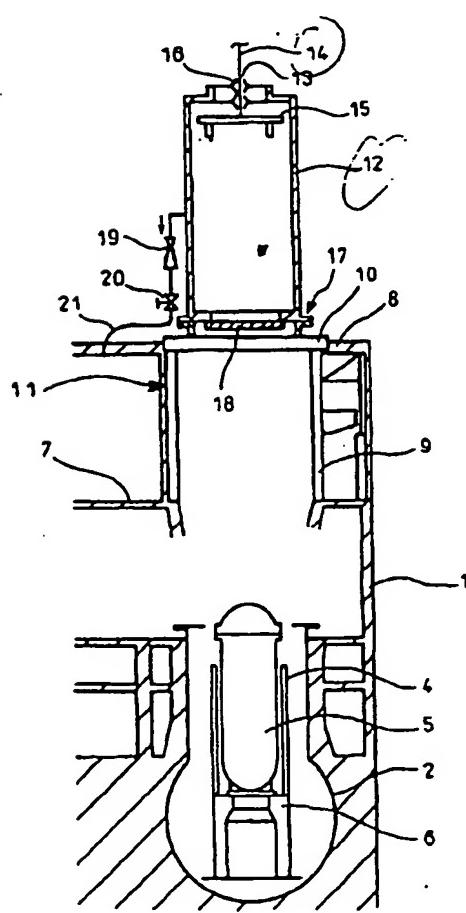
[図 1]



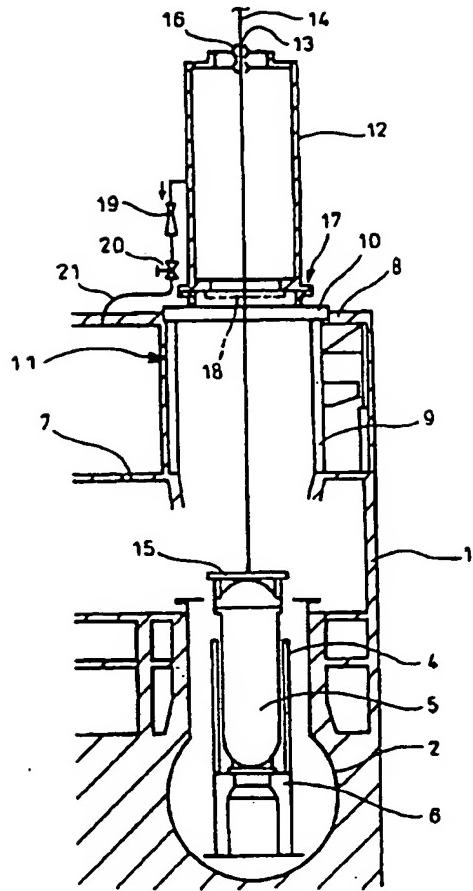
[図 2]



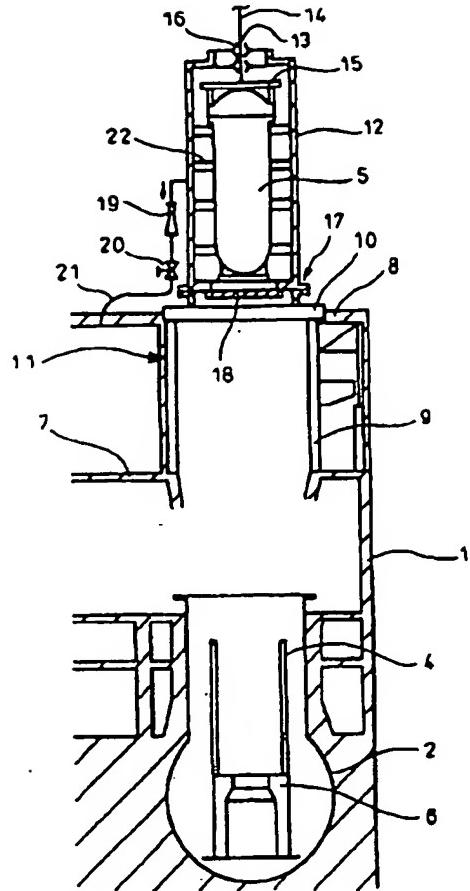
[図 3]



(図4)



(図5)



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